BS-200

Chemistry Analyzer

Service Manual

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- all installation operations, expansions, changes, modifications and repairs of this product are conducted by Mindray authorized personnel;
- the electrical installation of the relevant room complies with the applicable national and local requirements;
- the product is used in accordance with the instructions for use.

WARNING:

It is important for the hospital or organization that employs this equipment to carry out a reasonable service/maintenance plan. Neglect of this may result in machine breakdown or injury of human health.

NOTE:

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Company Contact

Manufacture:	**Shenzhen Mindray Bio-Medical Electronics Co., Ltd.**
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Preface

Who Should Read This Manual

This manual is written for service professionals authorized by Mindray.

Conventions Used in This Manual

Safety Symbols

This chart explains the symbols used in this manual.

When you see …		Then …
	WARNING:	Read the statement following the symbol. The statement is alerting you to an operating hazard that can cause personal injury.
	BIOHAZARD:	Read the statement following the symbol. The statement is alerting you to a potentially biohazardous condition.
	CAUTION:	Read the statement following the symbol. The statement is alerting you to a possibility of system damage or unreliable results.
	NOTE:	Read the statement following the symbol. The statement is alerting you to information that requires your attention.

Graphics

All graphics, including screens and printout, are for illustration purpose only and must not be used for any other purposes.

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1 Specifications

1.1 General Features

1 Dimension: 860mm×680mm×625mm (W×D×H, optional lower cabinet excluded); 860mm×680mm×1160mm (W×D×H, optional lower cabinet included)

2 Weight: 113kg (optional lower cabinet excluded; the optional lower cabinet weighs 51Kg)

3 Power supply: AC 110-130V/200-240V±10%, 50/60Hz

4 Input power: 1000VA

5 Test method: Endpoint, Kinetic and Fixed-time. Supporting double-reagent and double-wavelength

6 Calibration rule: Linear (one-point, two-point and multi-point), Logit-Log 4P, Logit-Log 5P, Exponential 5P, Polynomial 5P, Parabola and Spline

7 QC rule: Westgard multi-rule, Cumulative sum check, Twin-plot

8 Tests analyzed simultaneously: 19/38 (double/single-reagent)

9 Throughput: 200tests/h maximum

1.2 Features of Loading System

1 Sample/reagent disk: Round style with samples and reagents on the disk

2 Sample volume: 3-45μl, precision: 0.5μl

3 Sample position: 40

4 Reagent volume: 30-450μL, precision: 1μl

5 Reagent position: 40. Each position is available for the Mindray bottles only

6 Pre-dilution: Dilution ratio 4-150, taking the reaction cuvettes as containers

7 Probe: With a built-in level detector, equipped with auto safeguard, capable of tracking level

8 Washing function: Automatically washing interior and exterior of the probe, with carryover no more than 0.1%

9 Mixing bar: For single-reagent tests, it functions immediately (within the same period) after sample dispensing; for double-reagent tests, it functions immediately (within the same period) after dispensing of R2

1.3 Features of Photometric System

1 Light source: 12V/50VA tungsten-halogen lamp

2 Light splitting mode: Splitting by optical fiber, filtering by an interference filter

3 Half band-width: 10±2nm

4 Wavelength: 340, 405, 450, 510, 546, 578, 630, 670, 700nm (optional)

5 Absorbance range: 0-5Abs, 10mm optical path conversion

6 Reaction cuvette: 5×6×25mm, optical path: 5mm, volume: 900μl

7 Volume of reaction mixture: 180-500μl

8 Max. reaction time: 12 minutes

9 Reaction temperature: 37±0.3℃, with fluctuation no greater than ±0.1℃

1.4 Operating Interface

1 Operating system: Windows XP, Windows 2000

2 CPU: Above Pentium 733M

3 Memory: Above 128M

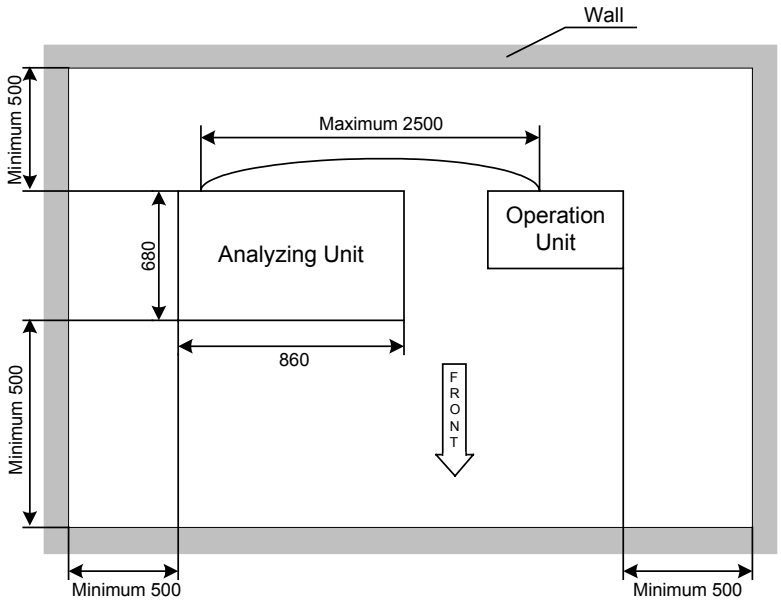
4 Hard disk: Above 40G

5 Display: Resolution 1024×768, color ≥8 bits

6 System interface: RS-232

2 System Installation

2.1 Space and Accessibility Requirements



Unit: mm

2.2 Power Requirements

- Power supply: AC 110-130V/200-240V±10%, 50/60Hz, three-wire power cord and properly grounded.
- The system should be connected to a properly grounded power socket. If possible, the system should be connected to a power line specially designed for medical devices.
- The distance between the power socket and the system should be less than 3 meters.

WARNING:

Make sure the power socket is grounded correctly. Improper grounding may lead to electric shock and/or equipment damage.

Be sure to connect the system to a power socket that meets the above-mentioned requirements and has a proper fuse installed.

NOTE:

It is recommended for hospitals to prepare a 2000VA online UPS.

2.3 Environmental Requirements

2.3.1 Installation Environment Requirements

- This system is for indoor use only.
- The bearing platform (or ground) should be level (gradient less than 1/200).
- The bearing platform (or ground) should be able to bear 100Kg weight.
- The installation site should be well ventilated.

CAUTION:

The system radiates heat when operating. A well-ventilated environment helps keep the room temperature stable. Use ventilation equipment if necessary. But if so, be sure not to expose the system to the direct draft that may lead to unreliable results.

- The site should be free of dust as much as possible.
- The site should not be in direct sun.
- The site should not be near a heat or draft source.
- The site should be free of corrosive gas and flammable gas.
- The bearing platform (or ground) should be free of vibration.
- The site should not be disturbed by large noise or power supply.
- The system should not be placed near brush-type motors and electrical contacts that are frequently turned on and off.
- Do not use such devices as mobile phones or radio transmitters near the system. Electromagnetic waves generated by those devices may interfere with operation of the system.
- The altitude height of the site should be lower than 2000 meters.

WARNING:

When the forward or backward gradient is more than 8 degrees, the system may tip over. Be sure to take proper measures when transporting and storing it.

2.3.2 Temperature and Humidity Requirements

Storage temperature and humidity

- The system should be stored in a 0˚C-40˚C environment with fluctuation less than ±2˚C /H.
- The relative humidity should be between 30%RH-80%RH and with no condensation.

CAUTION:

Storing the system in an environment other than the specified may damage the system.

Operating temperature and humidity

- When the system is running, be sure to fix the ambient temperature between 15˚C -30˚C with fluctuation less than ±2˚C /H.
- The ambient humidity should be between 35%RH-80%RH and with no condensation.

CAUTION:

Operating the system in an environment other than the specified may lead to unreliable test results.

If the temperature or relative humidity does not meet the above-mentioned requirements, be sure to use air-conditioning equipment.

2.4 Installation Procedure

2.4.1 Preparation for Installation

Ensure available installation fields in hospital: enough space, electrical environment, room temperature and humidity and other conditions as specified.

PC, monitor and printer are prepared and can be installed the system software and Maintenance and Test software at any moment.

NOTE:

Be sure the digital and date format of the Windows are same as them of the English version Windows.

The reagent, calibrator, the tool kit, lubricating grease are prepared (engineer also can take these parts by himself).

2.4.2 Beforehand Check

Go to the installation site and do the following beforehand check wok.

1 Check the delivery list for acceptance, and then unpack the wood package.

2 Make one copy of the original parameter configuration list that the engineer will take back for archiving. The original copy is to be kept by the hospital carefully.

3 Hold the probe arm by hand, and move it up and down to its full travel for 8 times respectively at the washing position, reaction disk position, inner and outer circles of the sample / reagent disk, so as to check whether the moving resistances are uniform at all directions.

Hold the mixing bar arm by hand, and move it up and down to its full travel for 8 times respectively at the washing position and reaction disk position, so as to check whether the moving resistances are uniform at all directions. Move the probes up and down to their full travel in turns to check whether their moving resistances are uniform. Then record the results in the following table.

Item	Result		Remark
Moving resistances of reagent /sample probe driver assembly at all directions	□ Uniform	□ Different	
Moving resistances of mixing bar driver assembly at all directions	□ Uniform	□ Different	

If the moving resistances are different, lubricate the driver assemblies, and record the results after lubrication in the **Remark** column.

2.4.3 Hardware Installation

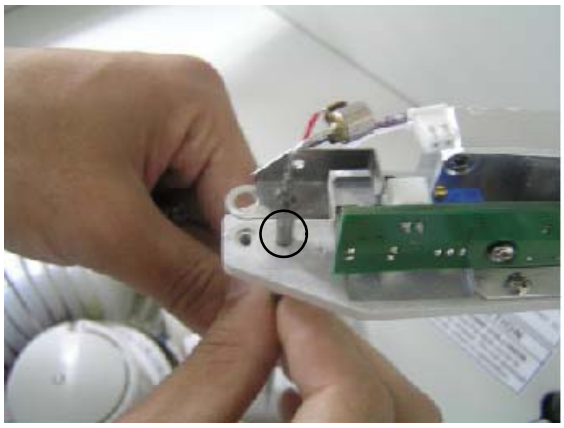
Install the probe

1 Take out the probe from the box, and remember there's a little tip also.

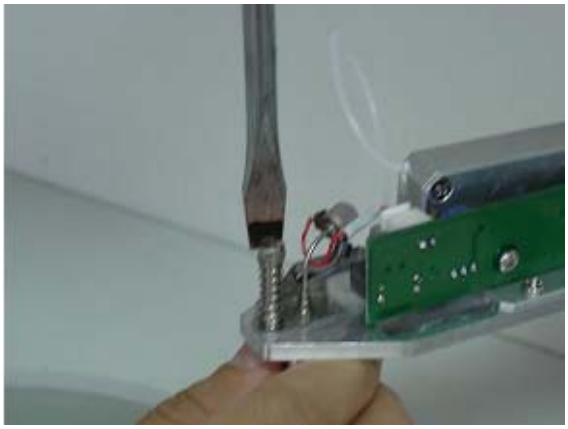
2 Take off the arm cover: Grab the lower parts of the arm cover with two hands and pull them slightly outwards and remove the cover upward from the arm base.

3 Remove the retaining screw with a screwdriver and take away the spring. Remember to move the arm to the highest position for convenient operation.

4 Insert the probe into the probe arm.

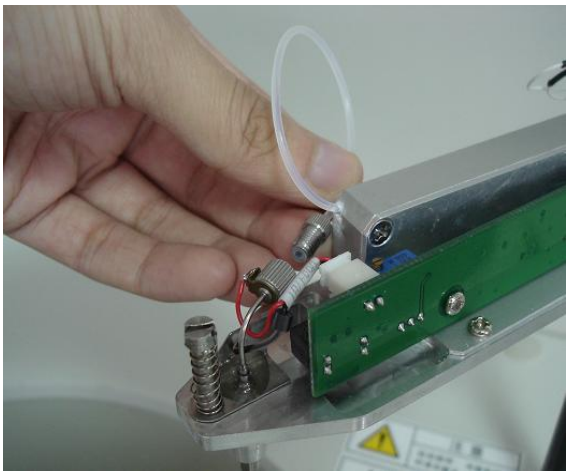


5 Sleeve the spring over the pole in the probe arm, and screw the retaining screw back onto the pole.

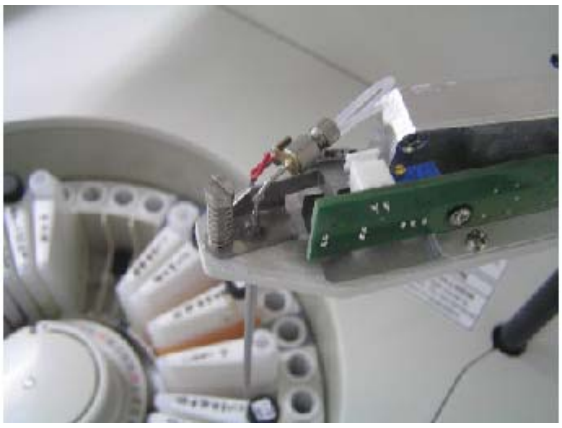


6 Insert the connector of the probe lead into corresponding jack on the level detection board. The probe arm is delicate. Exercise caution when inserting the connector. Excessive force may damage the connector and/or the level detection board.

7 Screw the probe's fluid connector back to the tubing connector. Note that excessive force may bend the probe.

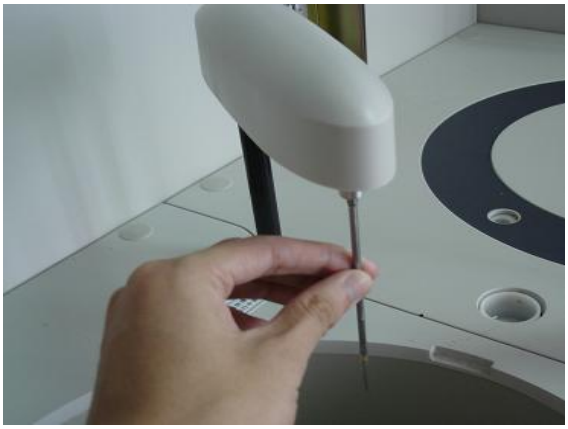


8 Then push the probe upward and then release the probe to check if it can move freely. If not, find the reason and solve the problem.



9 Installing the arm cover.

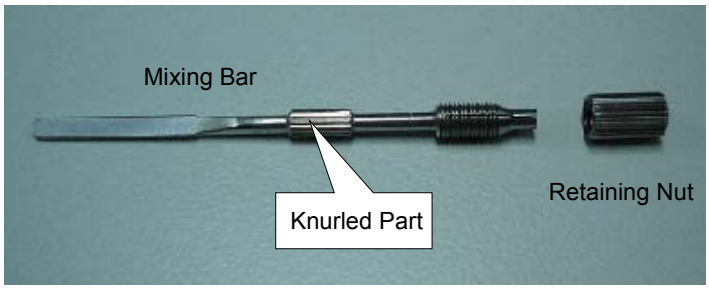
10 Pinch the probe by the part near the probe arm. Gently push the probe upward and then release the probe to see if it can move freely. If not, remove the arm cover and re-install it.



Install the mixing bar

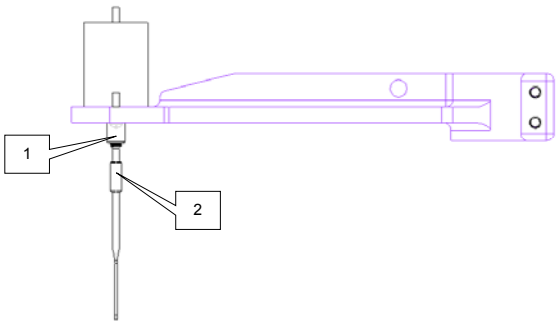
1 Rotate the bar arm to the highest position for convenient operation.

2 Take out the mixing bar and retaining nut from the box. Note that pinch the knurled part of the bar and take out it.



3 Pinch the new mixing bar by the knurled part and align the it to the bigger hole end of the retaining nut and gently screw it into the nut until the end of the bar is in line with the smaller hole end of the nut.

4 Pinch the mixing bar by the knurled part 2 and align the hole of the nut 1 to the axis on the bar arm, then push the bar upward in the direction of the axis until it can't proceed.



5 Tighten the nut by screwing clockwise with the other hand.

6 Check whether the bar is vertical to the bar arm.

If not, remove the bar and re-install it.

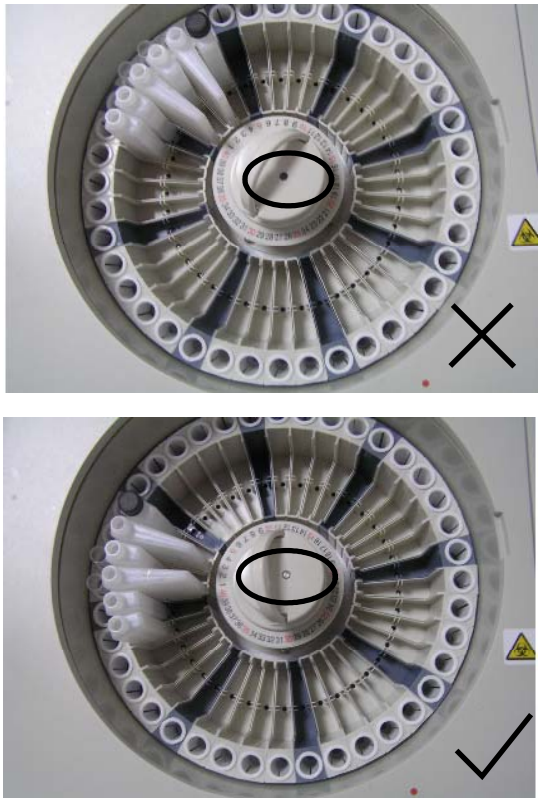
If so, proceed to the next step.

7 Pull the bar arm to its highest point and rotate it to move the bar to a position above its wash well.

Install the sample/reagent disk

1 Carry the sample/reagent disk. Keep the handle at the vertical position and put the disk in proper position.

2 Then rotate the disk nightly, until the point can be seen from the hole.



3 Put the handle back to horizontal position.

Connect the deionized water tank

1 Put the pickup tubes and the sensor into the deionized water tank, and then turn the cap of the deionized water tank clockwise.

2 Put the deionized water tank on an appropriate place.

3 Plug the red and the green connectors to their counterparts marked DEIONIZED WATER on the rear side of the analyzing unit and turn the connectors clockwise until secure.

4 Plug the sensor connector to its counterpart marked D-SENSOR on the rear side of the analyzing unit and turn it clockwise until secure.

Connect the waste tank

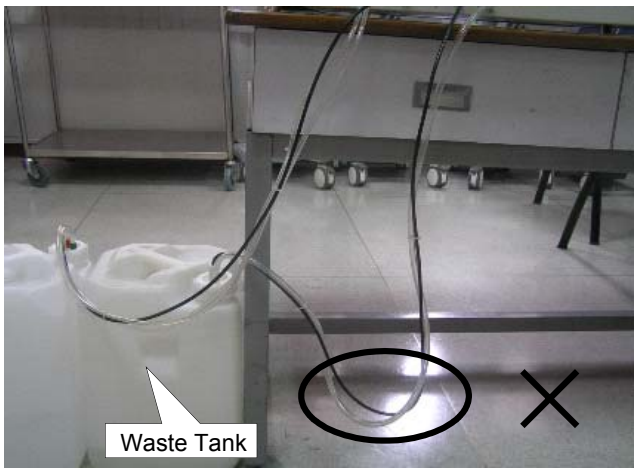
1 Put the waste tube and the sensor into the waste tank, and then turn the cap of the waste tank clockwise.

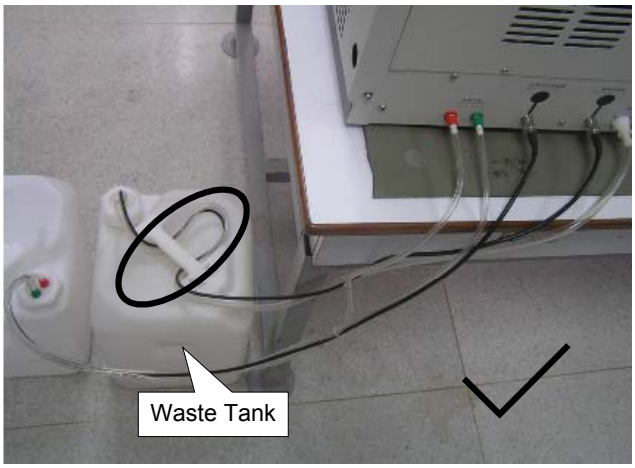
2 Put the waste tank on an appropriate place.

3 Keep pressing the pin on the waste connector marked WASTE on the rear side of the analyzing unit and grab the waste tap and insert it to the connector.

4 Plug the sensor connector to its counterpart marked W-SENSOR on the rear side of the analyzing unit and turn it clockwise until secure.

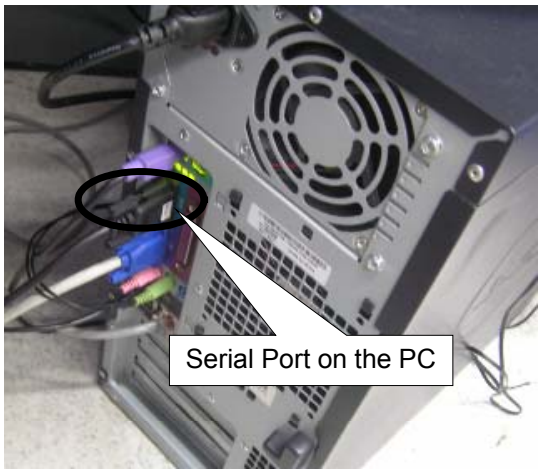
5 Be careful about the position of the waste tube, because the waste drive by its own gravity, so we have to make sure all of the waste tube is above the waste tank and below the analyzer.





Connect the PC to the Analyzing Unit

1 Connect the PC to the Analyzing Unit by serial communication cable.



Connect power cable and grounding wire of the analyzer

2.4.4 Software Installation

Install the system software

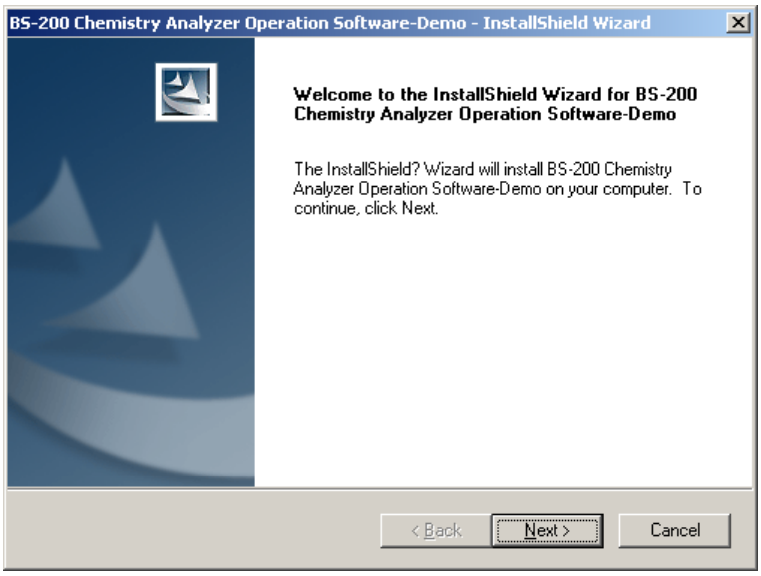
Before installing the system software, check the operating system and settings of the PC and make sure:

- Operating system: Windows XP, Windows 2000
- Memory: Above 128M
- Resolution: 1024×768
- Color: no less than 8 bits

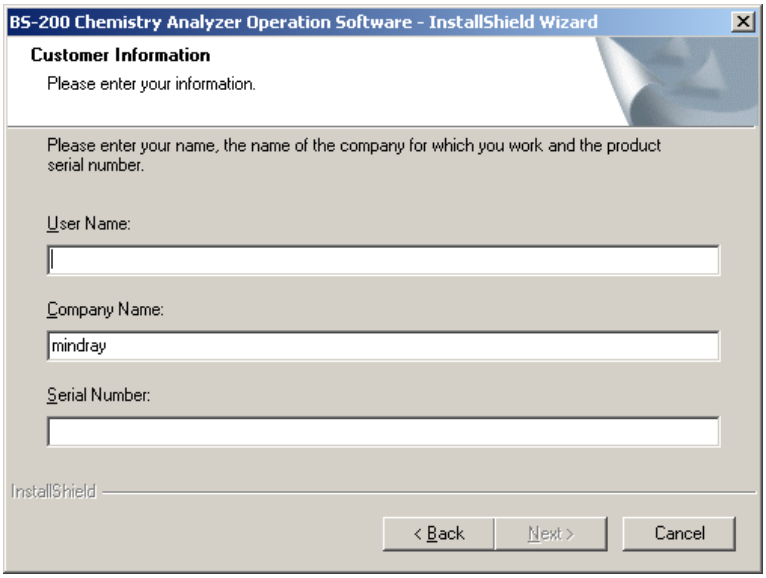
1 Power on the PC and start the Windows.

2 Double click the **Setup.exe** file at the directory of the installation CD.

3 Click the **Next** button.

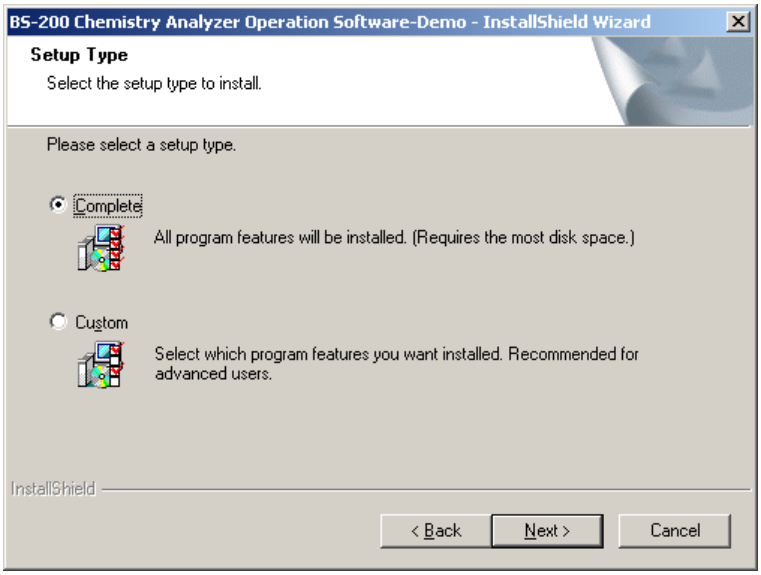

BS-200 Chemistry Analyzer Operation Software-Demo - InstallShield Wizard
Welcome to the InstallShield Wizard for BS-200 Chemistry Analyzer Operation Software-Demo
The InstallShield? Wizard will install BS-200 Chemistry Analyzer Operation Software-Demo on your computer. To continue, click Next.
< Back
Next >
Cancel

4 Enter the user name, company name and the serial number. The serial number is “11111111”.

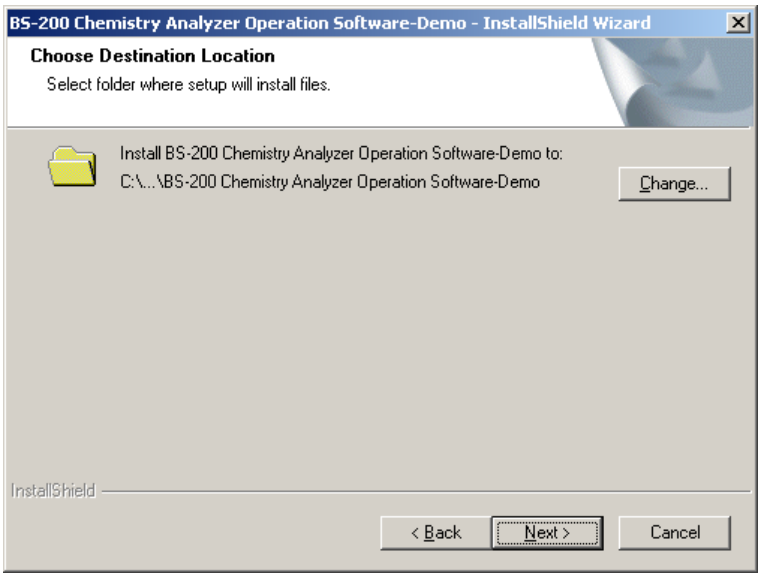

BS-200 Chemistry Analyzer Operation Software - InstallShield Wizard
Customer Information
Please enter your information.
Please enter your name, the name of the company for which you work and the product serial number.
User Name:
Company Name:
mindray
Serial Number:
InstallShield
< Back
Next >
Cancel

5 If you do not want to change the default installation directory of the software, click the **Next** button and go to the step 8;

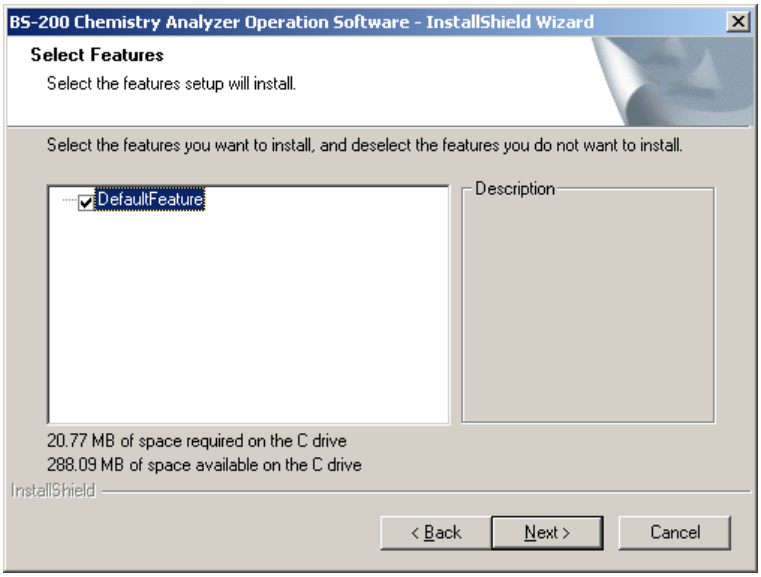
Otherwise, after selecting the **Custom**, click the **Next** button and go to the next step.


BS-200 Chemistry Analyzer Operation Software-Demo - InstallShield Wizard
Setup Type
Select the setup type to install.
Please select a setup type.
Complete
All program features will be installed. (Requires the most disk space.)
Custom
Select which program features you want installed. Recommended for advanced users.
InstallShield
< Back
Next >
Cancel

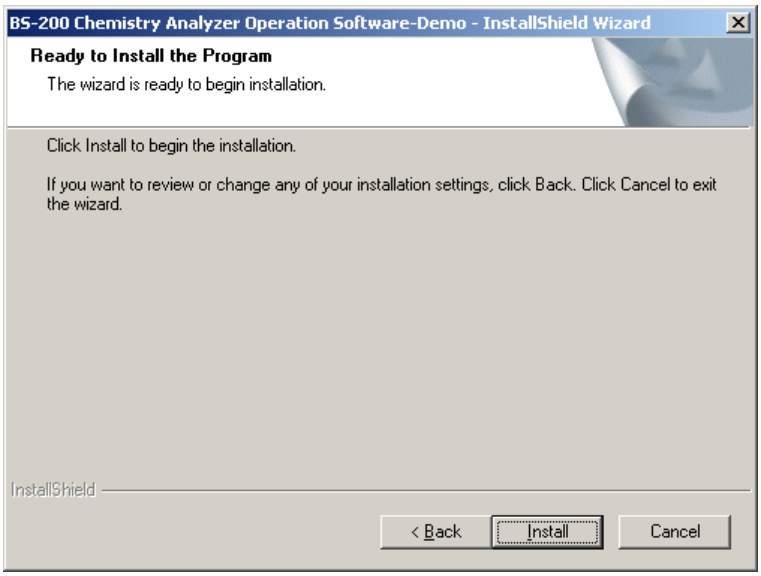
6 Click the **Change** button to change the installation directory of the software.


BS-200 Chemistry Analyzer Operation Software-Demo - InstallShield Wizard
Choose Destination Location
Select folder where setup will install files.
Install BS-200 Chemistry Analyzer Operation Software-Demo to:
C:\...\BS-200 Chemistry Analyzer Operation Software-Demo
Change...
InstallShield
< Back
Next >
Cancel

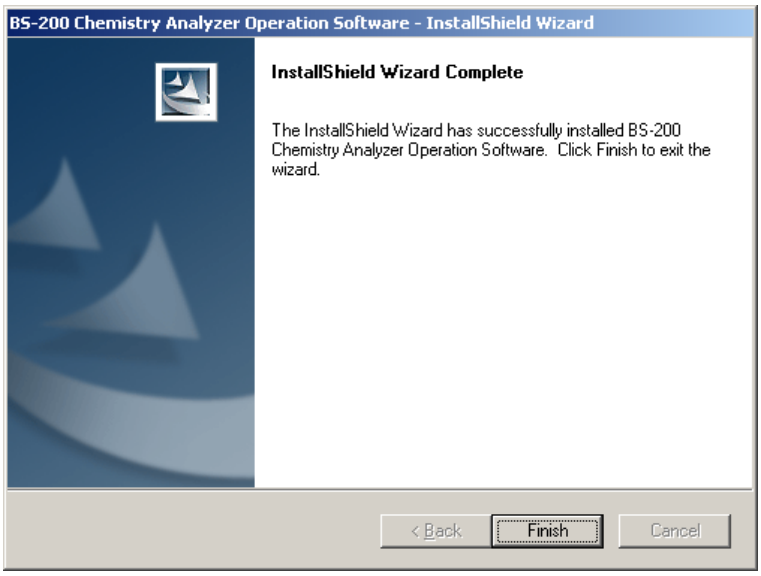
7 After selecting the features you want to install, click the **Next** button.


BS-200 Chemistry Analyzer Operation Software - InstallShield Wizard
Select Features
Select the features setup will install.
Select the features you want to install, and deselect the features you do not want to install.
DefaultFeature
Description
20.77 MB of space required on the C drive
288.09 MB of space available on the C drive
InstallShield
< Back
Next >
Cancel

8 Click the **Install** button.


BS-200 Chemistry Analyzer Operation Software-Demo - InstallShield Wizard
Ready to Install the Program
The wizard is ready to begin installation.
Click Install to begin the installation.
If you want to review or change any of your installation settings, click Back. Click Cancel to exit the wizard.
InstallShield
< Back
Install
Cancel

9 Click the **Finish** button when the installation is finished.


BS-200 Chemistry Analyzer Operation Software - InstallShield Wizard
InstallShield Wizard Complete
The InstallShield Wizard has successfully installed BS-200 Chemistry Analyzer Operation Software. Click Finish to exit the wizard.
< Back
Finish
Cancel

Install the driver of the printer

Shut down the PC

2.4.5 Turning on the analyzer

1 Fill the deionized water tank with deionized water.

2 Load detergent to position 39 and distilled water to position 40 on the reagent disk.

NOTE:

Mindray has specified the following detergents:

Acid: 0.1mol/l hydrochloric acid;

Alkaline: 0.5% (V/V) javel water.

Do not mix the acid detergent with the alkaline one.

Be sure to use the detergent recommended by Mindray. Otherwise, proper result may not be obtained.

Mindray recommends the acid and alkaline detergents be used alternately.

3 Switch on the analyzer as follows:

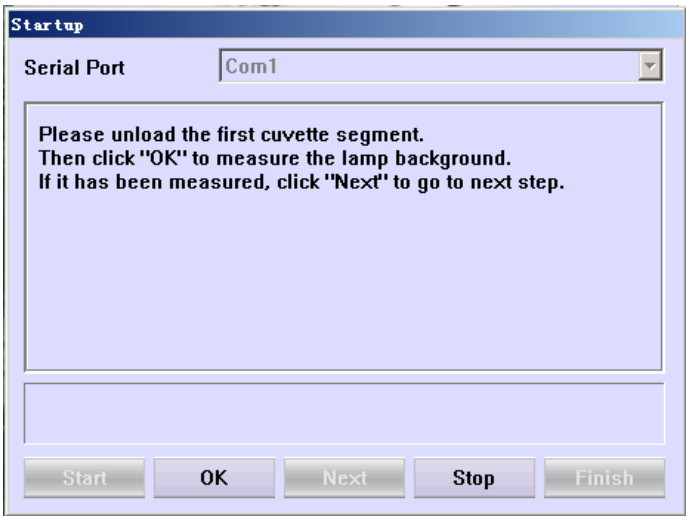
MAIN POWER → Power → monitor of PC → PC → printer

4 After logging on Windows, double-click the icon of system software on the desktop.

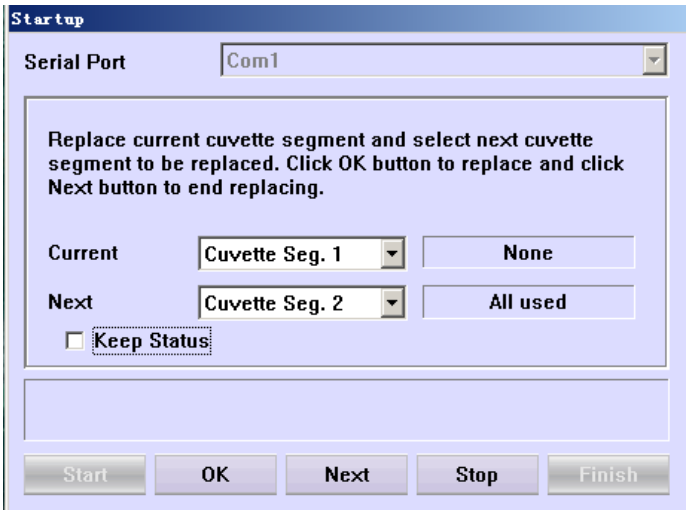
5 Enter user name “Admin” and Password “Admin”, and then press ”OK” to start the analyzer system.

6 The system automatically completes the self-check.

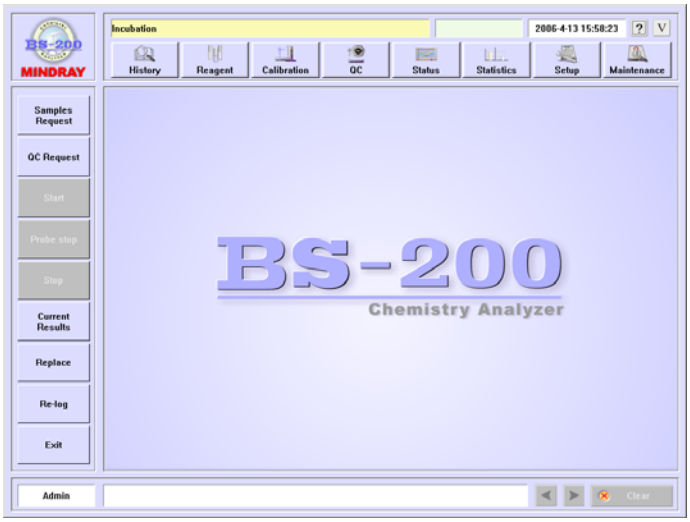
After that, the system asks you to unload the first segment of cuvettes to measure background (as shown in the figure below). Because it is the first time the analyzer runs, there is no cuvette in the reaction disk and you press ”OK” to go to the next step directly.



7 Add 8 new segments of cuvettes into the reaction disk to warm up. Check whether the surfaces of the cuvettes are smooth before loading. Do not touch the light transmission part of the cuvette in which the colorimetric reading is taken.

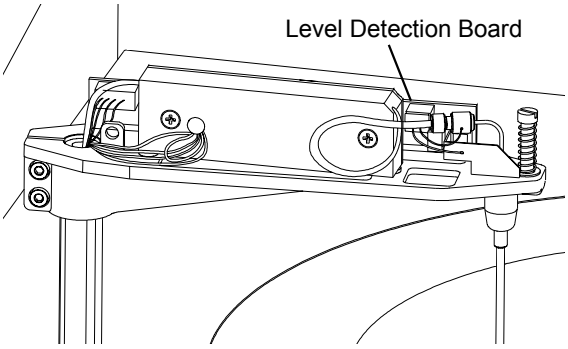


8 Operate according to the screen prompt until the main screen of the analyzer software is displayed (as below.



2.4.6 Adjusting

1 After starting the analyzer, adjust the resistance VR1 of the level detection board (in the probe arm) until the output of TP2 is 4.5V (reference test point is TP4).



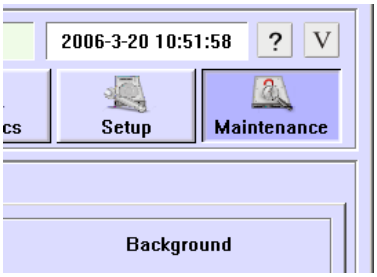
2 Select ***Maintenance→Daily Maintenance***, and then observe the system status and record it in the table below:

Reaction temperature				
Sample/reagent disk temperature				
Ambient temperature				
Waste tank	Abnormal (full)		Normal (not full)	
Deionized water	Abnormal (empty)		Normal (available)	
Printer	No printer		Normal	
Main unit	Unconnected	Idle	Running	
Reaction unit	Unconnected			

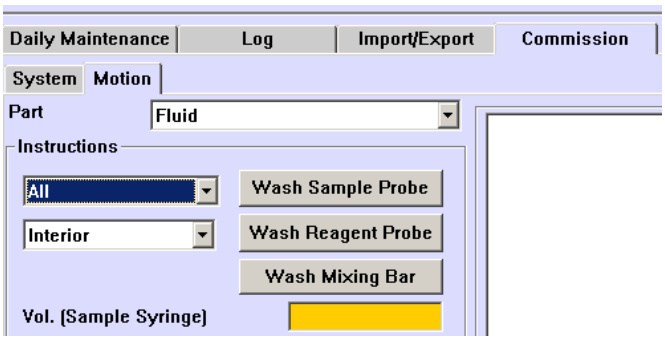
Sample/reagent unit	Unconnected			
Mixing unit	Unconnected			
Temperature unit	Unconnected			

Wavelength (nm)	Dark Current	Background
340		
405		
450		
510		
546		
578		
630		
670		
Reference		

3 On the ***Maintenance*** screen, select the ***Commission*** tab, and implement all sub-steps of each unit to see whether they are normal. In case of any exception, adjust it.



4 Wash the interior and exterior of the probe and mixing bar for several times to make all the tubing filled.



2.4.7 Setup and Test

1 Finish test, reagent and calibrator settings on the ***Setup***, ***Reagent*** and ***Calibration*** screens, and then conduct a double-reagent blank.

2 Request for calibration and samples and then debug the results.

3 After debugging the results, fill them in the table below:

Test	ALT	CREA	BUN		
Target value					
2sd range					
Test value 1					
Test value 2					
Test value 3					
Test value 4					
Test value 5					
Test value 6					
Test value 7					
Test value 8					
Test value 9					
Test value 10					

2.4.8 Training

Can the customer complete daily tests? Yes □ No □

Is the customer familiar with the analytical methods such as kinetic, two-point, endpoint? Yes □ No □

Is the customer familiar with the daily, weekly and monthly maintenance and relevant maintenance methods? Yes □ No □

Is the customer skilled in washing dust screens? Yes □ No □

Is the customer skilled in cleaning and replacing the probe and mixing bar? Yes □ No □

Is the customer skilled in replacing the plunger assembly of syringe? Yes □ No □

Is the customer skilled in replacing the lamp? Yes □ No □

Does the customer know the positions, roles and preparation methods of diluents and acid and alkaline detergents? Yes □ No □

3 System Description

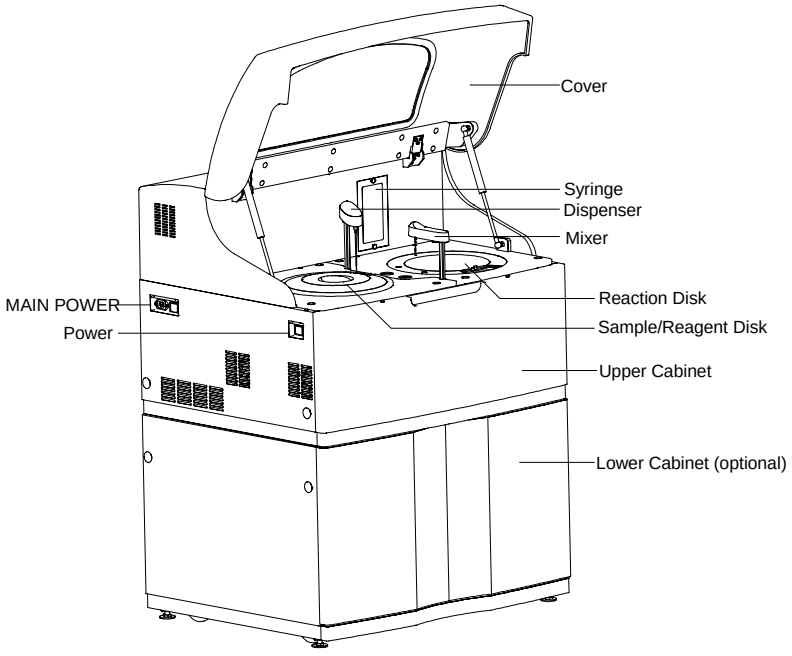
3.1 General

3.1.1 System Structure

The BS-200 consists of the analyzing unit, operation unit and output unit. The analyzing unit and operation unit are as shown in the figure below.

Figure 3-1 Overview of the analyzing unit and the operation unit

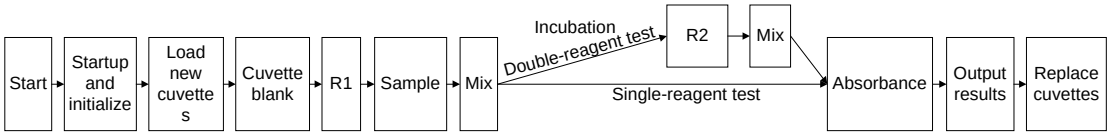
Figure 3-2 Front view



3.1.2 Work Flow

The measurement flow of the BS-200 is as follows:

Figure 3-3 Work flow of the BS-200



Test Procedures:

1 Power on the analyzer, then start up and initialize it. The initialization includes resetting mechanical assemblies, switching on the lamp and incubating by the temperature unit. You can't start testing unless the lamp becomes steady and temperature of the reaction disk reaches 37˚C constantly. This process may take about 15-20 minutes.

2 At the beginning of test, the probe and the mixing bar are washed.

3 The probe dispenses R1 to the cuvettes. It may skip to the next one when encountering a dirty cuvette.

4 The probe dispenses samples to the cuvettes. When the incubation time set for double-reagent tests is up, R2 is dispensed.

5 After reagents and samples are dispensed for a batch of tests, the probe and the mixing bar will be washed.

6 When the test is finished, a prompt will appear to inform you to replace the cuvettes manually.

7 When finishing all the tests, exit the system software and the analyzer will perform the shutdown procedure: washing the probe and bar with detergents, resetting the mechanical assemblies.

3.2 Major Components

The analyzing unit of the BS-200 consists of the dispensing system, temperature control system, photometric system, fluid system and etc.

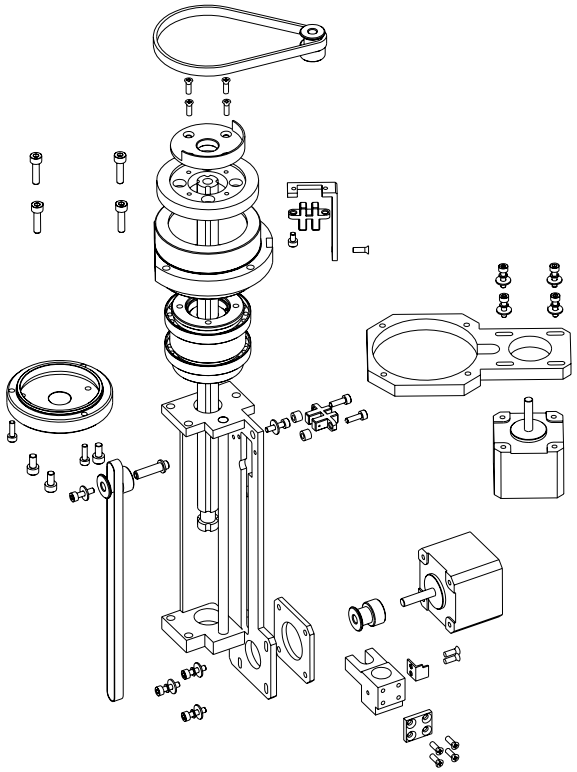
3.2.1 Dispensing System

The dispensing system consists of the probe module, mixing bar module, sample/reagent disk assembly and reaction disk assembly.

3.2.1.1 Probe Module and Bar Module

The mixing bar module is the same as the probe module, except that the knurled axis is 3cm shorter.

Figure 3-4 Drive Assembly



The drive assemblies of the probe module and the bar module have a horizontal and vertical photoelectric switch, which are used for defining horizontal and vertical initial positions of the probe and bar. The horizontal and vertical step motors precisely control the horizontal and vertical movements of the probe and bar. The synchronous belts serve as the gearing.

The shaft and the spline pair must corporate with each other precisely, so they should not be replaced separately.

3.2.1.2 Sample/reagent disk, reaction disk assemblies

The sample/reagent disk assembly consists of the sample/reagent disk and bearing support. The reaction disk assembly consists of the reaction disk and bearing support. The two bearing support are different in their upper connection block and their coders. The gaps of the coder define the positions where the disk should stop at. Each coder has two transducers for inducing the rotation and initial position of the disk.

Figure 3-5 Side view of the sample/reagent disk assembly

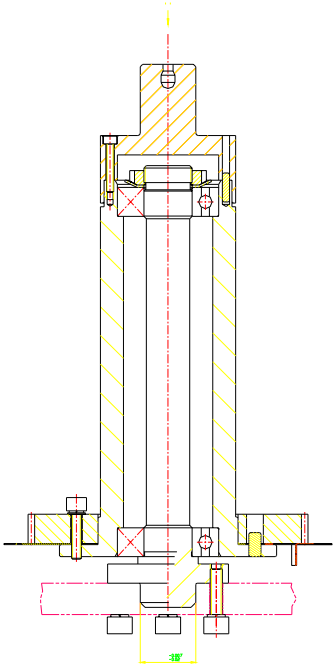
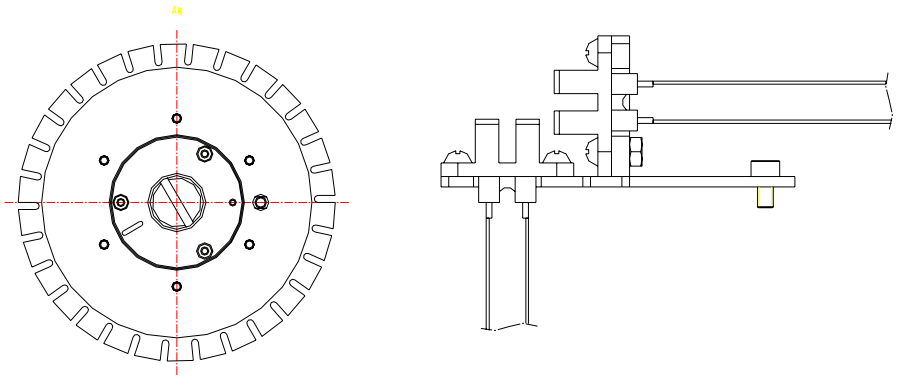


Figure 3-6 Coder of reaction disk



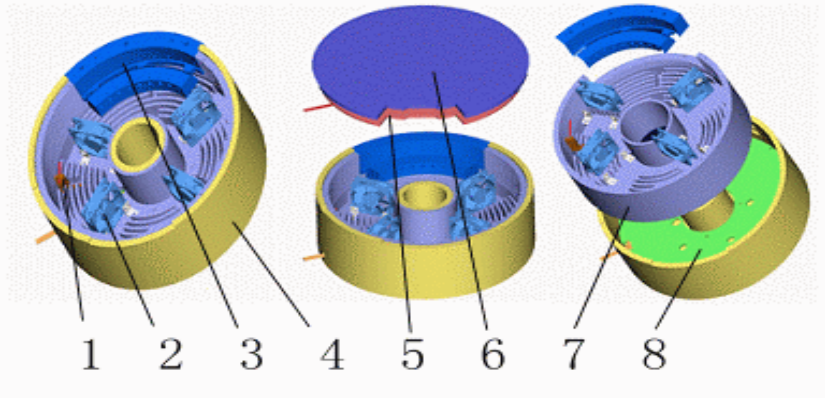
The step motors control the disk assemblies, and the synchronous belts serve as the gearing.

3.2.2 Temperature Control System

3.2.2.1 Temperature Control Assembly of Reaction Disk

The temperature control assembly of reaction disk consists of temperature-controlled pot, heat insulator, top heater, bottom heater, reaction disk/cuvettes, photoelectric seat, temperature transducer, fans and control circuit.

Figure 3-7 Structure of the temperature control assembly



1-Temperature transducer and support		2-Fans
3-Photoelectric seat	4-Heat insulator	5-Top heater
6-Cover	7-Temperature-controlled chamber	8-Bottom heater

■ Temperature-controlled chamber

The temperature-controlled pot, heat-insulator, photoelectric seat and the cover constitute an enclosed cavity, in which the reaction disk rotates. The heat-insulator, with good heat insulation, protects the temperature-controlled chamber from being interfered by external environment. There is a gap on the cover, which is used for loading/unloading reaction cuvettes manually.

■ Heater

Top heater: square in shape, 110/220VAC, 125W

Bottom heater: ring in shape, 110/220VAC, 350W

Total power: 475W.

The heaters compensate the heat for incubating the reagents and maintaining the temperature of the temperature-controlled chamber.

■ Fans

Fans are used in series in the temperature-controlled chamber, so as to circulate the air in the chamber and enhance the convective heat exchange. There are four fans in the chamber. All of them have alarm function.

■ Temperature transducer

It feeds back the air temperature at the position near the reaction cuvette. With an overheat protection switch, the temperature transducer can disconnect the pot from the power supply to avoid overheat and fire when the temperature inside the pot is up to about 55°C. The switch can also be reset automatically when the temperature inside the pot decreases to about 35°C.

■ Control

PID control. PID parameters can be self-adjusted at any time.

■ Safety precaution

The power of the two heaters is 110/220V, and the total power is nearly 0.5kW, so the following precautions are considered: grounding protection of the

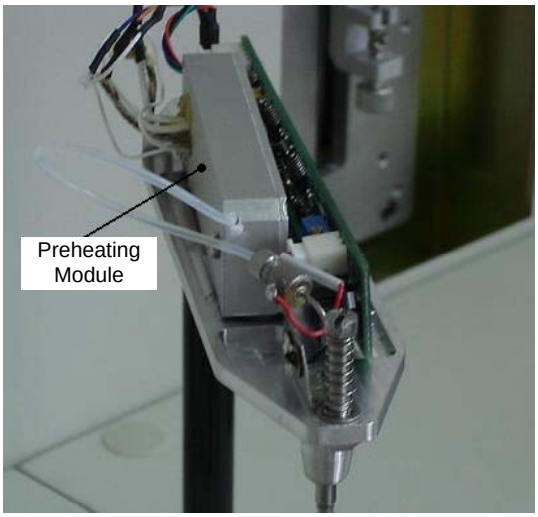
temperature-controlled pot, temperature switch protection against controller failure and fan protection.

3.2.2.2 Reagent Preheating

The preheating assembly consists of two aluminum plates, a Teflon tube, heating components, transducer, temperature switch, thermal conductive colloid, a section of tubing and the probe. The transducer detects the temperature, and then transmits it to the temperature controller. Thus the heating assembly is controlled, and the temperature is controlled.

The temperature of the thermal source of the preheater is 45°C. The initial temperature of the reagent is 2-8°C when it is taken out of the refrigerator. When the reagent passes the heater, its temperature increases quickly. Then the reagent is added into the reaction cuvette and the preheating process is finished.

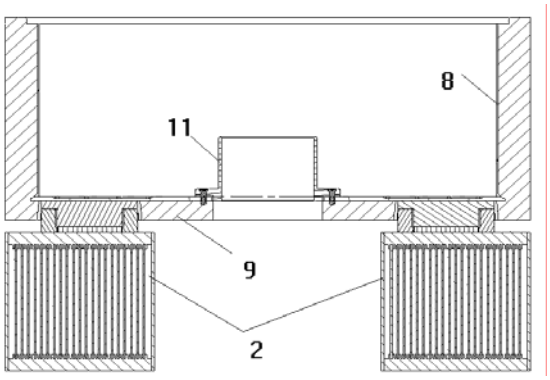
Figure 3-8 Reagent preheating assembly



3.2.2.3 Reagent Refrigeration

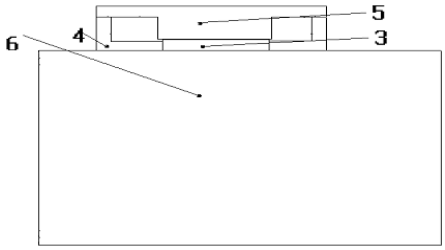
The refrigeration module consists of refrigeration chamber 8, heat-insulator 9, cover, reagent disk, rotor sleeve 11, temperature transducer, circuit and two refrigeration assemblies 2. The refrigeration module is as shown in the figure below.

Figure 3-9 Reagent refrigeration module



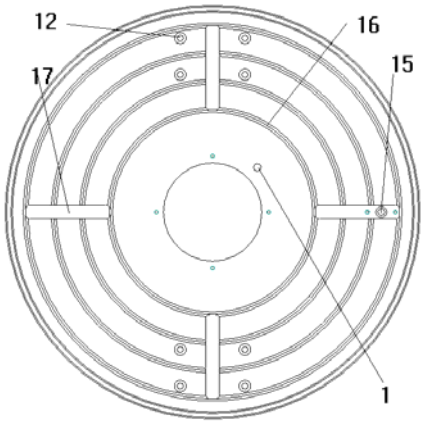
The key components of refrigeration assembly include refrigeration accumulation block 5, connector 4, Peltier 3 and radiator 6, as shown in the figure below. Each analyzer has two such refrigeration assemblies.

Figure 3-10 Refrigeration assembly



If you want to replace any part of the refrigeration assembly, screw the eight screws 12 (as shown in the figure below) of the reagent chamber and replace it.

Figure 3-11 Reagent chamber (bottom view)



3.2.3 Photometric System

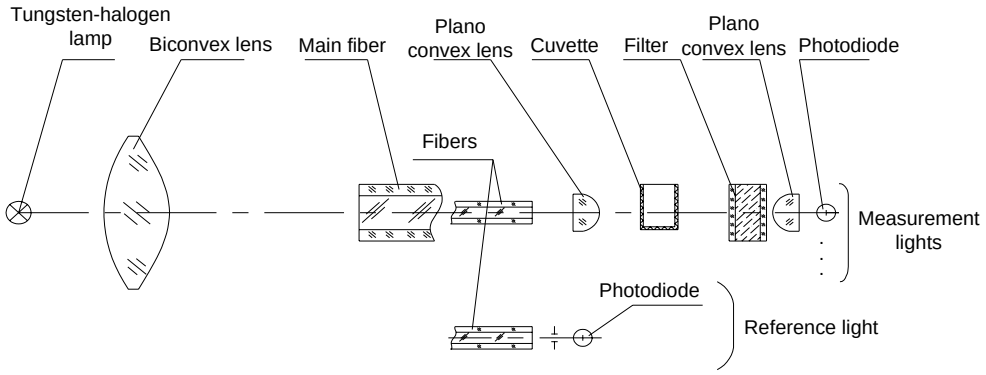
The photometric system consists of measurement photometric systems and a reference photometric system. The former provides 8 monochromatic lights to measure the absorbance of the reaction liquid in the rotating reaction cuvettes, while the latter compensates the former to make the measurement more accurate.

In the BS-200, the 700nm is optional. You can see the fiber of 700nm in the analyzing unit but the fiber does not work because there is no photoelectric conversion board for the wavelength.

The lamp gives out the lights, which are divided with optical fibers. One becomes the reference light, monitoring the working status of the lamp. Other 8 monochromatic lights go into the cuvettes of the reaction disk, transmit through the cuvettes and optical filters of specific wavelengths, and then go to the photoelectric conversion board. The electric signal, converted from the optical signal, is amplified and converted on the A/D conversion board, and then sent to the main control board, which will submit the absorbance to the PC for calculation.

The absorbance is taken when the reaction cuvette rotates to the corresponding optical path. Absorbance of 8 cuvettes can be taken simultaneously.

Figure 3-12 Photometric principles



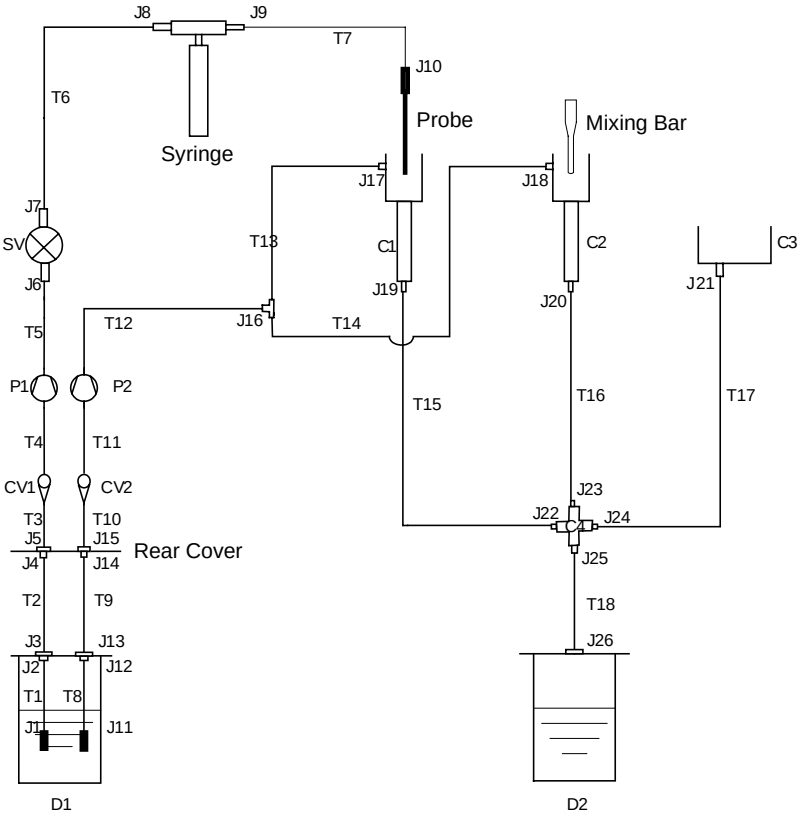
3.2.4 Fluid System

The fluid system washes the probe/bar and dispenses reagents/samples.

3.2.4.1 Washing

The fluid system of the BS-200 consists of deionized water tank, wash pump, solenoid valve, syringe, probe, wash well and waste tank.

Figure 3-13 Fluid system



As shown in the figure above, the fluid system consists of interior washing and exterior washing parts.

The interior washing circuit begins from the deionized water tank, passes CV1 (Check Valve), and enters P1 (Interior Pump). Then the circuit goes through SV (solenoid valve), syringe and the probe. Finally, the waste water goes into the probe wash well C1 after washing the probe.

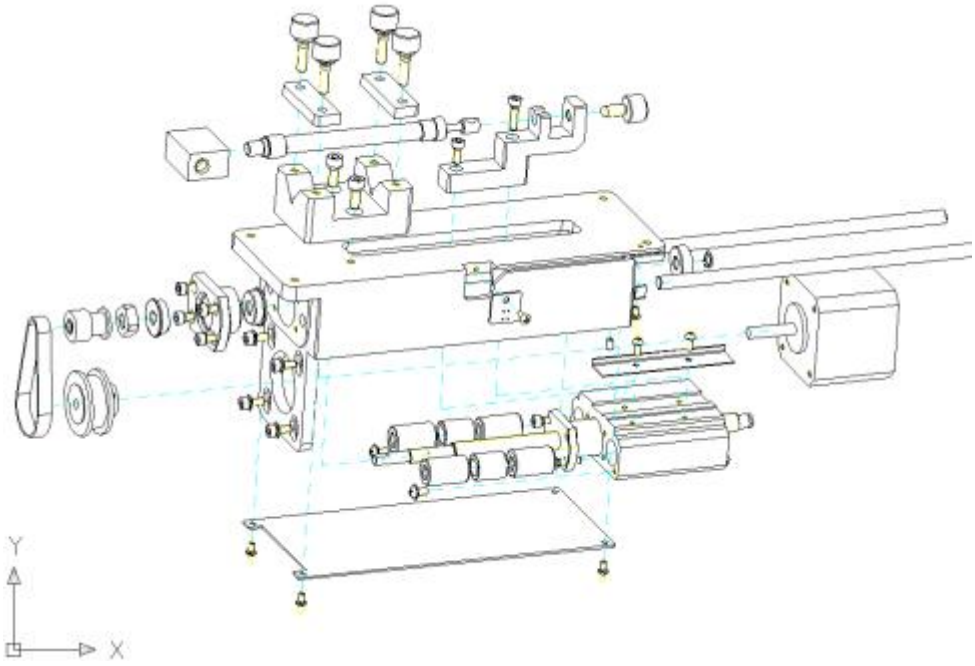
The exterior washing circuit begins from the deionized water tank, goes through CV2 (Check Valve), and then enters P2 (Exterior Pump). When the pump is running, the detergent goes through J16 (three-way) and finally enters the probe wash well C1 and mixing bar wash well C2.

The waste water from C1 and C2 goes through C4 (four-way), converging with the fluid of the reagent refrigeration module C3, and finally enters the waste tank.

3.2.4.2 Dispensing

The syringe assembly controls the aspiration/dispensing volume by controlling the travel of the syringe. It is the key part of the fluid system.

Figure 3-14 Syringe assembly



The step motor, through the synchronous belt, controls the ball screw. The photoelectric switch on the side controls the travel of the syringe.

4 Functions of Boards

4.1 Hardware System

The BS-200 chemistry analyzer is integrated with the following units:

- Main unit: Main control board
- Drive unit: Drive board
- Data conversion unit: A/D conversion board + 9 photoelectric conversion boards
- Level detection unit: Level detection board
- Reagent refrigeration unit: Reagent refrigeration board
- Power supply unit: PFC board, 5V/12V board and 24V board

Figure 4-1 Hardware system

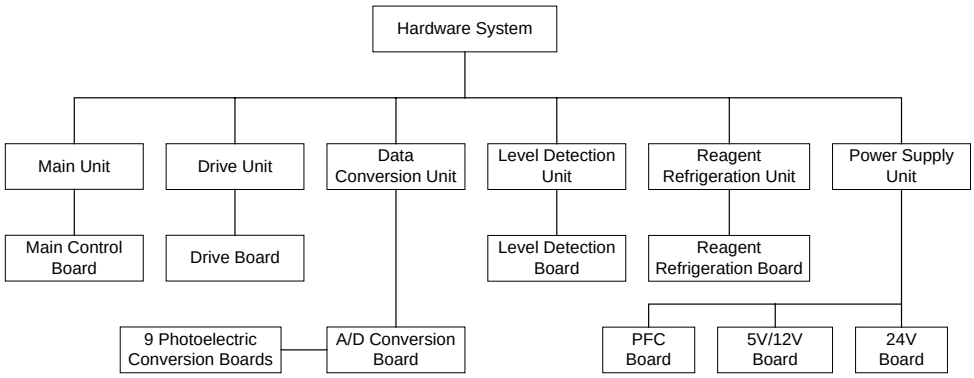
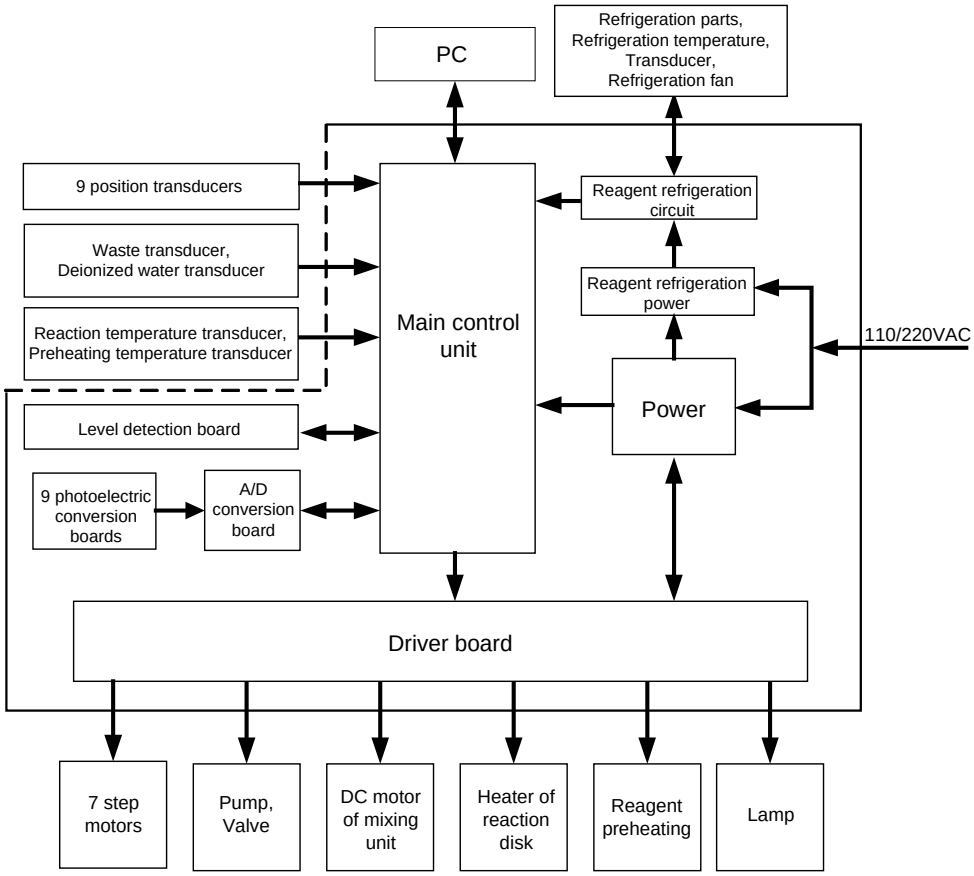


Figure 4-2 Connection of Boards

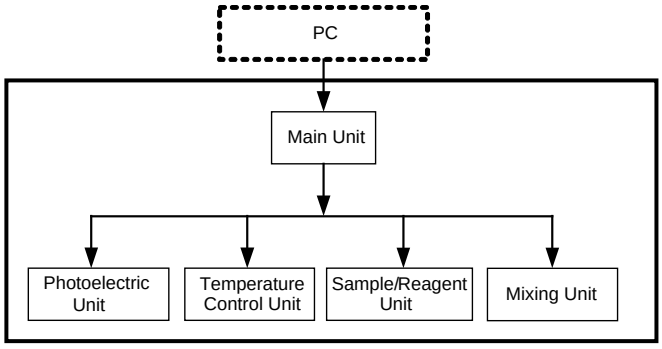


4.2 Main Control Board

The main control board is the control center of the whole hardware system. It consists of the control circuits of 1 main unit and 4 functional units (photoelectric unit, temperature unit, sample/reagent unit and mixing unit). Each functional unit has an MCU. They communicate in multi-unit mode and thus compose the whole control system.

The main control board communicates with the 4 subunits through the extended serial port, and stores the photoelectric data in FIFO mode that serves as the data channel between the main unit and the photoelectric unit.

Figure 4-3 Structure of main control board



4.2.1 Main Unit

The main unit communicates with the PC through RS-232C, and communicates with the 4 units through the extended serial port.

4.2.2 Photoelectric Unit

Through the serial port, the photoelectric unit receives commands from the main unit, controls the A/D conversion board and converts the received photoelectric signals to electric ones, and controls rotation of the reaction disk.

4.2.3 Temperature Unit

The temperature unit detects and controls the temperature for reacting and reagent preheating.

4.2.4 Sample/Reagent Unit

The sample/reagent unit is to:

- Control rotation of the sample/reagent disk.
- Control vertical/horizontal movements of the probe.
- Control vertical movement of the syringe.
- Switch on/off the wash pump and solenoid valve.
- Detect signals sent from each relevant transducer.

4.2.5 Mixing Unit

The mixing unit receives commands from the main unit through the serial port and completes the following actions:

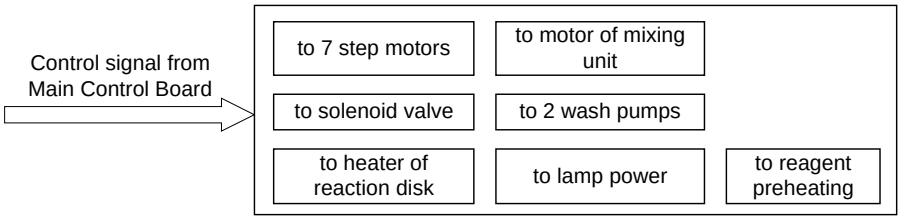
- Controlling vertical/horizontal movements of the mixing bar
- Controlling the movement of the DC motor
- Switching on/off the washing pump and solenoid valve
- Detecting signals sent from each relevant transducer.

4.3 Drive Board

The drive board mainly consists of the step motor drive circuit and pump/valve drive circuit.

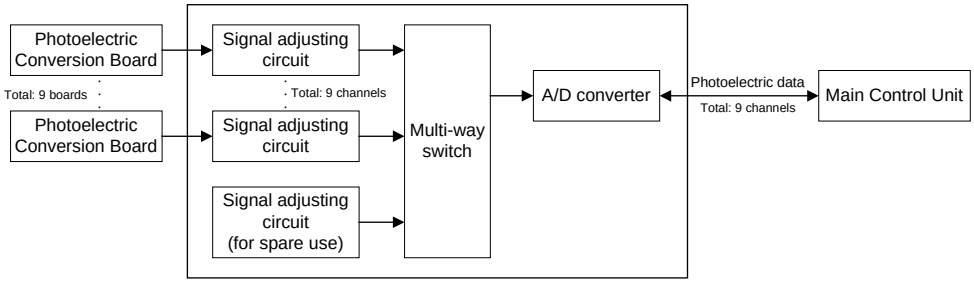
The drive board is to receive the control signals from the main control board and control the drive components. See the figure below for details about the drive board.

Figure 4-4 Drive board


Control signal from Main Control Board
to 7 step motors
to motor of mixing unit
to solenoid valve
to 2 wash pumps
to heater of reaction disk
to lamp power
to reagent preheating

4.4 A/D Conversion Board

Figure 4-5 A/D conversion board



The A/D conversion board is used to:

- Adjust the 9 channels of converted signals, convert them into digital ones and then transmit them to the CPU of the photoelectric unit.
- Adjust the gains of the photoelectric signals.

The photoelectric signals are converted respectively by the photoelectric conversion board of corresponding wavelength. Photoelectric conversion boards for different wavelengths have different gains and cannot be replaced by each other.

4.5 Reagent Refrigeration Board

The reagent refrigeration board consists of four circuits, including refrigeration control circuit, fan feedback circuit, temperature indication circuit and voltage conversion circuit. The refrigeration control circuit and temperature indication circuit are driven by the 12V, while the other two by the 12VFAN.

In the BS-200, the following fans are driven by the reagent refrigeration board:

- 2 radiator fans for the peltiers
- 1 radiator fan for the lamp
- 1 radiator fan for the drive board
- 4 temperature control fans for the reaction disk

There are several LEDs on the reagent refrigeration board to indicate the status of the power supply, peltiers, fans and refrigeration temperature. Refer to the table below for details.

Table 4-1 LEDs on reagent refrigeration board

What to indicate	Net Name of LED	Color of LED	Description	
			On	Off
Power supply	12VLED	Green	12V works normally	12V goes wrong
	12VFAN_LED	Green	12VFAN works normally	12VFAN goes wrong
Peltiers	PELTIER_LED	Green	Peltiers work normally	Peltiers go wrong
Fans	FAN1_LED	Red	Corresponding fan goes wrong	Corresponding fan works normally
	FAN2_LED	Red		
	FAN3_LED	Red		
	FAN4_LED	Red		
Refrigeration temperature	GREEN_LED	Green	Temperature is within 0-15℃	Temperature is beyond 0-15℃
	YELLOW_LED	Yellow	Temperature is below 0℃	Temperature is above 0℃
	RED_LED	Red	Temperature is above 15℃	Temperature is below 15℃

4.6 Level Detection Board

When aspirating reagents/samples, the BS-200 chemistry analyzer requires the probe to dip into the liquid for a specific depth, so as to avoid carryover that has impacts on test results, and to avoid air aspiration when the reagent/sample is insufficient.

The level detection board detects the fluid level of sample and reagent.

4.7 System Power Supply

The power supply unit of the BS-200 consists of three boards: 5V/12V, 24V and PFC board.

The powers supplied by this unit include:

- AC 110/220V - Heater
- 12V/4.5A - Lamp
- 12V/10A - Peltiers
- 12V/4.7A – Boards, pumps and valves
- 5V/4.5A - Boards
- 24V/5A – Step motors

4.7.1 PFC Board

- EMI filter network.
- Providing APFC to conform to the IEC61000-3-2.
- AC/DC conversion. Supplying the +390V and VDD voltage to drive the 24V board and 12V&5V board.
- Supplying stable 12V(4.5A) for the lamp.
- Controlling the 24V, 12V(4.7A) and 5V outputs through the Power of the analyzing unit

4.7.2 24V Board

- Transferring AC to the heater and controlling the heater.
- Converting the 390V into 24V.

The 24V of this board is output under the control of the Power of the analyzing unit.

4.7.3 5V/12V Board

The 5V/12V board converts the 390VDC from the PFC board to 12V(10A), 12V(4.7A) and 5V. The 12V(4.7A) and 5V are controlled by the Power of the analyzing unit.

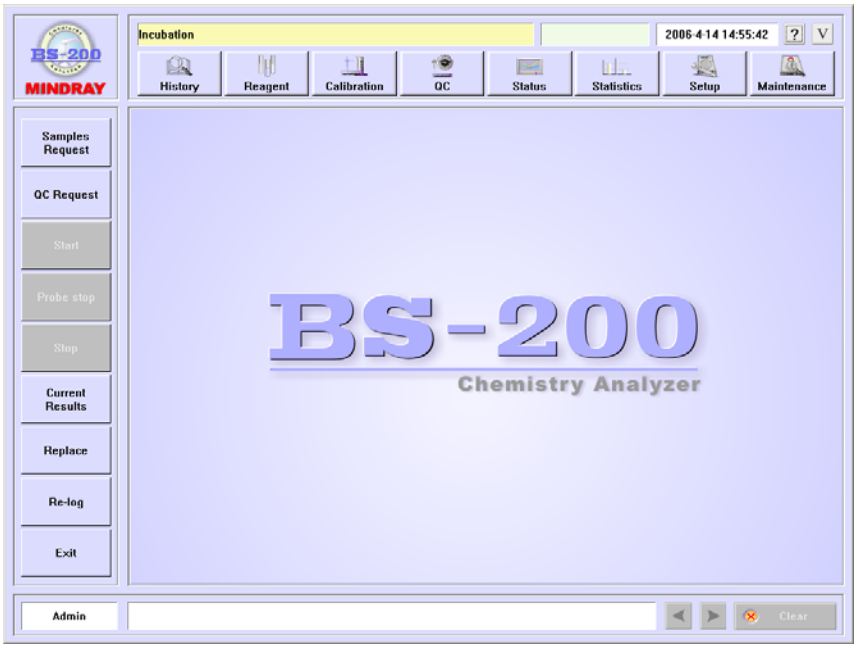
The power supply of the BS-200 is controlled by two switches (MAIN POWER and Power). The 12V(10A) is controlled by the MAIN POWER of the analyzing unit separately and powered by the 5V/12V board after the analyzer is started, while others are controlled by the Power of the analyzing unit.

5 Software Introduction

The BS-200 software is composed of the system software and the control software.

5.1.1 System Software

Figure 5-1 System software interface



The BS-200 system software manages the test and sample information entered by you, generates a test procedure based on the requested tests, and sends test instructions to the analyzing unit. These instructions inform the analyzing unit to start testing and then output and save the results.

The system software controls the analyzing unit through the control software. They communicate with each other through the serial port upon the specific protocols.

The system software is composed of 14 modules: calculation, startup, shutdown, database, interface, serial port receiving/sending, processing received data, error processing, testing, commissioning, failure restore, replacing cuvettes, printing and protocol encapsulation.

5.1.1.1 Calculation

This module calculates the calibration parameters and the concentration of the reaction mixture. The calculation procedure includes:

- AD → absorbance
- Absorbance → response
- Response → calibration parameters
- Calibration parameters, response → concentration of the mixture

5.1.1.2 Startup

This module initializes the operation unit and analyzing unit to prepare for testing.

The startup process includes: checking and initialization of the operation unit, communication with and initialization of analyzing unit.

The operation unit is checked and initialized before the main screen is displayed.

1 To check the operating system of the PC

The system software must run under Windows XP or Windows 2000. Otherwise, a prompt will appear indicating that the system software cannot run under the operating system other than the specified, and then the system software will be closed automatically.

2 To check the screen resolution of the current operating system

The system software must run under the resolution of 1024×768. Otherwise, the software can't be displayed in full screen and a warning will be given. You can set the resolution immediately and check again, or exit the software and start it again after setting the resolution.

3 To check the color of the current operating system

If the color is less than 8 bits, the software can't be displayed normally and a prompt will be given to inform you of wrong color. You can set the color immediately and check again, or exit the software and start it again after setting the color.

4 To disable the screen saver

The system software must keep displayed while running. To prevent the screen saver from disturbing you in operating and observing, the screen saver should be disabled. A warning will be given for disabling failure, you can try it again or neglect or exit the software.

5 To disable hibernation

Hibernation may disturb the testing. A warning will be given for disabling failure, you can try it again or neglect or exit the software.

6 To initialize the database

The current database is compressed and restored and will backed up to the historical database if the year is changed. When operation is failed, a warning will be given to ask you to restore the database. You can exit the software after confirming.

7 To check the printer

Check whether a printer has been set and connected to the PC.

Startup will not be affected when there is no printer. When you need to print, the system will check the printer again.

After the operation unit is checked and initialized, the startup screen will be displayed. The operation unit begins communicating with and initializing the analyzing unit. In case that it is the first startup or the last startup was failed, you can select a serial port and then click ***Start*** to start the analyzing unit. Otherwise the system starts the analyzing unit automatically.

Communication with and initialization of the analyzing unit is finished during startup.

1 To set and initialize the communication port

Set the parameters regarding the serial port: baud rate, data bit, start bit, stop bit, parity bit, sending/receiving buffer, control protocol, and start the serial port receiving/sending thread and received data processing thread.

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

2 To shake hand with the analyzing unit

A handshake instruction is sent to the analyzing unit. If the analyzing unit responds to it by sending a handshake instruction back to the PC, it indicates the PC handshakes with the analyzing unit successfully. Otherwise, another one will be sent again for 3 times at a specific interval (2s).

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

3 To check the self-check results of the analyzing unit

An instruction is sent to check the self-check result of each unit. The units have been checked when the analyzing unit is started, and the results are stored in the main unit.

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

4 To download parameters to the analyzing unit

An instruction is sent to download parameters to the analyzing unit. If there is no response within 30s, the instruction will be sent again for 3 times.

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

5 To reset the mechanical parts

An instruction is sent to reset mechanical parts of each unit.

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

6 To switch off the lamp and test the dark current

If the dark current is beyond the specified range, a warning will be given but will not affect the startup and testing.

7 To switch on the lamp and test the background

A dialog box is displayed to ask you to unload the first cuvette segment, so as to test the dark current and background. After unloading, the system starts testing the background.

If unloading is failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

If the background approaches to the dark current, a prompt will be given indicating lamp on failed, lamp failure or brightness too low, and the startup is halted. You can exit the startup process.

If the background is less than the specified threshold, a prompt will be given indicating brightness too low, which will affect the test results. You can neglect it or exit the startup process.

If the background approaches to the threshold, the startup process will not be affected. However, when the main screen is displayed, a prompt will appear indicating that the brightness approaches to the threshold and the lamp should be replaced.

8 To test cuvette blank

A dialog box is displayed to ask you to replace all the cuvette segments with new ones. After confirmation, the analyzer will start testing the cuvette absorbance and mark the used cuvettes.

If loading is failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

9 To reset the mechanical parts and wash the probe and bar

An instruction is sent to reset all the mechanical parts and wash the interior, exterior of the probe and the mixing bar.

If failed, a prompt will be given and the startup is halted. You can take actions immediately and try again, or exit the startup process.

10 To check the temperature and finish startup process

If the temperature becomes steady and is within specified range, the analyzer will enter standby status, otherwise the incubation status.

5.1.1.3 Shutdown

This module restores the operation unit and analyzing unit to the default status.

During this process, the analyzing unit and the operation unit will be shut down.

You can start the shutdown process by selecting ***Exit*** on the main screen or ***Shutdown*** on the ***Maintenance*** → ***Commission*** → ***System*** screen. Then the system will display a dialog box and start the shutdown automatically.

The following operations are conducted to shut down the analyzing unit.

1 To switch off the lamp

If failed, the system will enter the failure status and the shutdown is ended.

2 To unload all the used cuvettes

When a prompt is displayed to ask you to unload all the used cuvettes, you should unload them and confirm. Then the system will continue the shutdown. If failed, the system will enter the failure status and the shutdown is ended.

3 To wash the probe and the bar

When a prompt is displayed to ask you to prepare acid or alkaline detergent, you should prepare it and confirm. Then the system will wash the probe and the bar in enhanced washing mode. If failed, the system will enter the failure status and the shutdown is ended.

4 To reset the mechanical parts

Each mechanical part will be reset. If failed, the system will enter the failure status and the shutdown is ended.

The following operations are conducted to shut down the operation unit.

1 To stop all the threads

2 To stop the timer

3 To close the database

5.1.1.4 Database

This module saves the settings and test data, such as system, patient, sample information and test data.

5.1.1.5 Interface

This module provides an interface for you to view each status and result, make settings, request tests, start and stop testing, etc.

5.1.1.6 Serial Port Receiving/Sending

This module establishes the communication between the system software and control software. It sends the instructions in the sending buffer to the main unit, through which the instructions are transferred to the specified units. Then the echo, results, test data and warnings received from the main unit are saved in the received data buffer.

5.1.1.7 Processing Received Data

This module processes the received echo, results, data, warnings, running reports and requests. It gets the frame information from the received data buffer, sets corresponding commands, records the measured photoelectric data and warnings, and calls the error processing module when an error occurs.

5.1.1.8 Error Processing

When an error occurs, this module finds the causes and evaluates the level and type of the error. Additionally, it records the error logs, reminds you of error, and refreshes the system status.

5.1.1.9 Testing

The testing module is to:

- Check the reaction temperature periodically.
- Form a test list according to the requests and divide the testing into several periods, which are converted to instructions and saved in the buffer.
- Maintain the test list according to the results from the data processing module.
- Inform the database and interface modules to update relevant information.

5.1.1.10 Commissioning

This module sends relevant commissioning instructions and processes the commissioning results.

It sends instructions regarding simple operations, commissioning, parameter downloading, temperature control switch, and etc, and processes the corresponding results.

5.1.1.11 Failure Restore

This module restores the failed parts as required by you.

The failed parts can be restored actively or passively. The active restoring means when a failure occurs during startup, shutdown or testing, the system will try to execute the instruction again in terms of settings or reset the mechanical parts of corresponding units and wash the probe/bar. While the passive restoring means the system restores the failed parts only when you sends the ***Restore*** instruction.

5.1.1.12 Replacing Cuvettes

This module assists you in unloading used cuvettes and loading new ones.

Cuvettes can be replaced during startup, shutdown or under normal condition.

Normal condition refers to incubation, standby and failure status. Cuvettes are replaced in same procedures during startup, shutdown and under normal condition.

After replacing, the system will test the cuvette blank automatically and mark the used cuvettes.

5.1.1.13 Printing

This module prints out in proper format the test results, calibration results, QC results or statistic results.

5.1.1.14 Protocol Encapsulation

This module provides encapsulation functions for all the instructions in accordance with the communication protocol.

5.1.2 Control Software

The control software receives the instructions from the system software, analyzes them and drives the corresponding units of the analyzing unit to execute them. And it also transmits the data from the analyzing unit to the system software.

The units of the analyzing unit can be functionally divided into the following ones: main unit, photoelectric unit, reaction unit, sample/reagent unit, mixing unit and temperature unit. The functions of these units are listed in the following table.

Unit	Function
Main unit	Receives macroinstructions from the PC, decomposes them into a series of action instructions, and then delivers them to destination units (in specific order) at a certain interval.
	Monitors the status of each unit, and transmits the data converted by the photoelectric unit to the PC.
Photoelectric unit	Detects photoelectrical data of the solution in reaction cuvettes, and amplifies and converts it. And stores data at the dual port FIFO for the main unit to read and transmit to the PC.
Reaction unit	Contains 80 cuvettes.
	Rotates specified cuvette, following the instruction sent from the main unit, to the reagent/sample dispensing position, mixing position and photoelectric detection position at specified wavelength.
Sample/Reagent unit	Contains 40 reagent positions in the inner circle and 40 sample positions in the outer circle.
	Rotates specified reagent bottles, following the instruction sent from the main unit, to the reagent aspirating position.
	Rotates specified sample tubes, following the instruction sent from the main unit, to the sample aspirating position.
Mixing unit	Receives instructions from the PC, and controls the mixing bar to mix the solution in the cuvette where the reagent and sample has been dispensed and that has been rotated to the mixing position.
	Moves the mixing bar to the wash well, and washes it after each mixing to avoid carryover.
Temperature control unit	Controls the reaction temperature, reagent preheating temperature and refrigeration temperature.

6 Maintenance and Service

6.1 Cleaning and Washing

WARNING:

The probe tip is sharp and can cause puncture wounds. To prevent injury, exercise caution when working around the probe.

BIOHAZARD:

Wear gloves and lab coat and, if necessary, goggles.

Dispose of the used gauze in accordance with your local or national guidelines for biohazard waste disposal.

Dispose of the waste in accordance with your local or national guidelines for biohazard waste disposal and consult the manufacturer or distributor of the reagents for details.

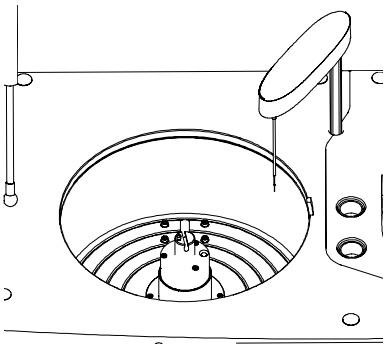
6.1.1 Cleaning Probe

1 Place the Power to OFF.

2 Remove the cover from the sample/reagent disk.

3 Remove the sample/reagent disk.

4 Pull the probe arm to the highest point by hand. Rotate the probe arm to move the probe to a position above the sample/reagent compartment and convenient to operate.



5

CAUTION:

The tweezers may scratch the probe. Exercise caution when using it to clean the probe. Avoid direct contact between the tweezers and the probe. Do not use excessive force when cleaning the probe. Otherwise it may bend.

NOTE:

Mindray recommends the acid and alkaline detergents be used alternately for this purpose. For instance, if the acid detergent has been used for last maintenance, the alkaline detergent had better be used for this time.

Pinch acid or alkaline detergent-soaked gauze with tweezers and gently clean the exterior of the probe until it is clean and smooth.

6 Pinch deionized water-soaked gauze to clean the probe.

7 After cleaning, gently pull the probe arm to its highest point and rotate the probe arm to move the probe to a position above the wash well.

8 Load the sample/reagent disk.

9 Close the cover.

6.1.2 Cleaning Mixing Bar

1 Place the Power to OFF.

2 Pull the mixing bar arm to the highest point by hand. Rotate the bar arm to move the bar to a position convenient to operate.

3

CAUTION:

The tweezers can scratch the bar. Exercise caution when using the tweezers to clean the bar. Avoid direct contact between the tweezers and the bar. Do not use excessive force when cleaning the bar. Otherwise it may bend.

NOTE:

Mindray recommends the acid and alkaline detergents be used alternately for this purpose. For instance, if the acid detergent has been used for last maintenance, the alkaline detergent had better be used for this time.

Pinch acid or alkaline detergent-soaked gauze with tweezers and gently clean the exterior of the mixing bar until it is clean and smooth.

4 Pinch deionized water-soaked gauze to clean the mixing bar.

5 After cleaning, gently pull the bar arm to its highest point and rotate the bar arm to move the bar to a position above the wash well.

6.1.3 Cleaning Sample/Reagent Compartment

1 Place the Power to OFF.

2 Remove the cover from the sample/reagent disk.

3 Take out all calibrators, controls, samples, reagents, distilled water and detergent from the sample/reagent disk.

4 Remove the sample/reagent disk.

5 Wash the disk with clean water and wipe it dry with clean gauze.

6 Use clean gauze (water or disinfector-dipped gauze if necessary) to clean the inside of the compartment.

7 Load the sample/reagent disk.

8 Close the cover.

6.1.4 Cleaning Wash Well of Probe

1 Place the Power to OFF.

2 Pull the probe arm to its highest point. Rotate the arm to move the probe away from the wash well.

3 Clean the inside of and the place around the wash well with cotton swabs.

4 Pull the probe arm to its highest point and rotate it to move the probe to a position above the wash well.

6.1.5 Cleaning Wash Well of Mixing Bar

1 Place the Power to OFF.

2 Pull the mixing bar arm to its highest point. Rotate the bar arm to move the bar away from the wash well.

3 Clean the inside of and the place around the wash well with cotton swabs.

4 Pull the mixing bar arm to its highest point and rotate it to move the bar to a position above the wash well.

6.1.6 Cleaning Panel of Analyzing Unit

1 Place the Power to OFF.

2 Wipe the panel of the analyzing unit with clean gauze (water or disinfector-dipped gauze if necessary).

6.1.7 Washing Deionized Water Tank

CAUTION:

The deionized water to be used on the analyzer must meet the CAP Type II water requirements.

1 Place the Power to OFF.

2

CAUTION:

After removing the cap of the deionized water tank (together with the pickup tube and sensor), place it on a clean table.

Unscrew (counter-clockwise) the cap (together with the deionized water pickup tube and the sensor).

3 Wash the tank interior with deionized water. Use a clean brush to clean the interior if necessary.

4 Wash the pickup tube and the sensor with deionized water. Use clean gauze to wash them if necessary.

5 Wipe water off the tank exterior, pickup tube and sensor cable with clean gauze.

6 Add deionized water into the tank.

7 Screw (clockwise) the cap (together with the pickup tube and sensor) back onto the tank until secure.

CAUTION:

When placing the deionized water tank, ensure the top of the tank is lower than the bottom of the upper cabinet.

Ensure the deionized water pickup tube is not blocked, bent, or twisted.

6.1.8 Washing Waste Tank

BIOHAZARD:

Exercise caution and do not spill the waste onto other people or things.

1 Place the Power to OFF.

2

BIOHAZARD:

After removing the cap of the waste tank (together with the waste tube and sensor), place it on an appropriate place to avoid biohazard contamination.

Unscrew (counter-clockwise) the cap (together with the waste tube and the sensor).

3 Empty the waste tank.

4 Wash the tank interior with clean water. Soak the tank with disinfector if necessary.

5 Wash the waste tube and the sensor with clean water.

6 Wipe water off the tank exterior, waste tube and sensor cable with clean gauze.

7 Screw (clockwise) the cap (together with the waste tube and sensor) back onto the tank until secure.

CAUTION:

When placing the waste tank, ensure the top of the tank is lower than the bottom of the upper cabinet.

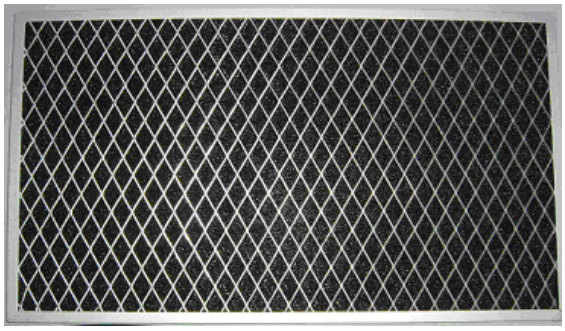
Ensure the waste tube is over the tank and not blocked, bent, or twisted. A blocked, bent or twisted waste tube may lead to wastewater overflow that may damage the analyzer.

6.1.9 Washing Dust Screens

1 Place the MAIN POWER to OFF.

2 Use a screwdriver to unscrew the screws on the left and right plates and remove the two plates.

3 Remove the dust screens from the plates. The dust screen is as shown in the figure below.



4 Wash the screens with clean water and dry them by airing.

5 Install the screens back to the left and right plates.

6 Install the left and right plates with screws.

6.2 Replacing

WARNING:

The probe tip is sharp and can cause puncture wounds. To prevent injury, exercise caution when working around the probe.

BIOHAZARD:

Wear gloves and lab coat and, if necessary, goggles.

CAUTION:

Please use Mindray-recommended consumables. Other consumables may decrease the system performance.

6.2.1 Unclogging Probe

When the probe is clogged, the fluid flow will become abnormal. Follow the steps given below to remove, unclog and install the probe.

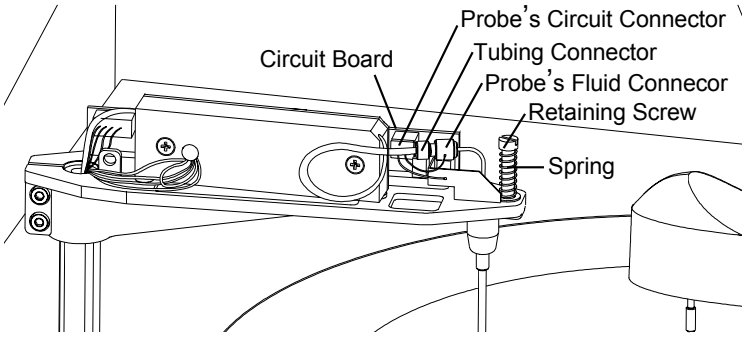
6.2.1.1 Removing Probe

1 Place the Power to OFF.

2 Remove the cover from the sample/reagent disk.

3 Pull the probe arm to its highest point. Rotate the probe arm to move the probe to a position above the sample/reagent compartment and convenient to operate.

4 Grab the lower part of the arm cover with two hands and pull them slightly outwards and remove the cover upward from the arm base. After you remove the cover, the inside structure of the probe arm is as shown in the figure below.



5 Hold the probe's fluid connector with one hand and the tubing connector with the other. Rotate the tubing connector counter-clockwise until it disconnects from the probe. Remove the tubing from the probe.

6 Press the circuit board with one hand and disconnect the probe's circuit connector from the board with the other hand.

CAUTION:

Exercise caution when disconnecting the connector. Excessive force may damage the connector and/or the circuit board.

7 Use a small screwdriver to remove the retaining screw on the probe and take out the spring.

8

WARNING:

Store the removed probe in a safe place where it will neither endanger people working around the area nor be damaged.

NOTE:

Exercise caution when pulling the probe away from the arm.

Slowly pull the probe away from the probe arm. Exercise caution so that the gasket inside the probe does not drop out and if it does, store it in a clean place for later installation.

6.2.1.2 Unclogging Probe

BIOHAZARD:

Dispose of the used needle in accordance with your local or national guidelines for biohazard waste disposal.

1 Use a needle to unclog the probe from the tip.

6.2.1.3 Installing Probe

1 Place the Power to OFF.

2 Insert the probe back into the hole on probe arm, and align the hole on probe plate to the rotor inside the arm.

3 Sleeve the spring on the rotor and screw the retaining screws to secure.

4 Pinch the probe by the part near the probe arm. Gently push the probe upward and then release the probe to see if the spring can move freely.

If so, proceed to the next step.

If not, check for errors and try again after removing the errors.

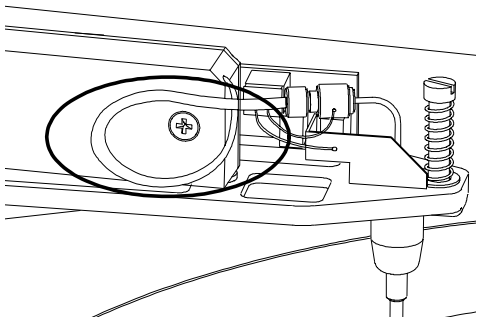
5 Connect the probe's circuit connector back to the circuit board.

6 Ensure the gasket is inside the probe.

7

CAUTION:

The fluid tube inside the probe arm should be bent into a circle when being installed.



Exercise caution when connecting the probe. Excessive force may bend the probe.

Screw (clockwise) the probe's fluid connector back to the tubing connector.

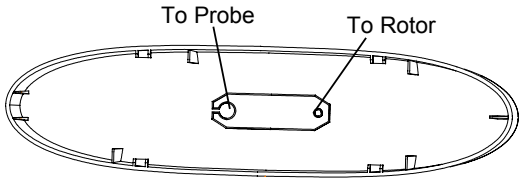
8 Add deionized water to a clean cup. Immerse the probe tip into the water by about 3mm and the LED on the circuit board will be lighted. Take the probe tip out of water, and the LED will be off. If the test succeeds, proceed to the next step.

If not, there is something wrong with the level detection board.

9 Check the marks inside the probe arm cover to see the orientation of the cover. Install the cover back to the probe arm.

CAUTION:

The marks inside the probe arm cover are shown in the figure below.



10 Pull the probe arm to its highest point and rotate it to move the probe to a position above the wash well.

11 Install the sample/reagent disk.

6.2.2 Replacing Probe

If the probe is bent or damaged, it must be replaced immediately. Follow the procedure given below to replace the damaged or bent probe.

1 Remove the bent or damaged probe as instructed by **6.2.1.1 Removing Probe**.

BIOHAZARD:

Dispose of the bent or damaged probe in accordance with your local or national guidelines for biohazard waste disposal.

2 Install a new probe as instructed by **6.2.1.3 Installing Probe**.

6.2.3 Replacing Mixing Bar

If the mixing bar is damaged, it must be replaced immediately. Follow the procedure given below to replace the damaged mixing bar.

WARNING:

When replacing the bar, pinch the bar only by the knurled part and do not touch the other part of the bar. Protect the flat part of the bar from been scratched.

BIOHAZARD:

Dispose of the damaged mixing bar in accordance with your local or national guidelines for biohazard waste disposal.

1 Place the Power to OFF.

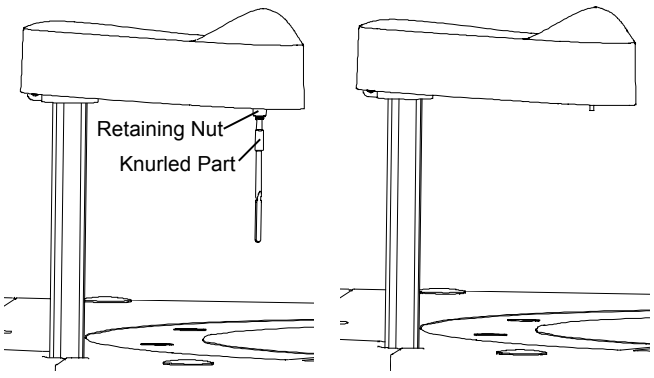
2 Gently pull the bar arm to its highest point and rotate it to move the bar to a position convenient to operate.

3

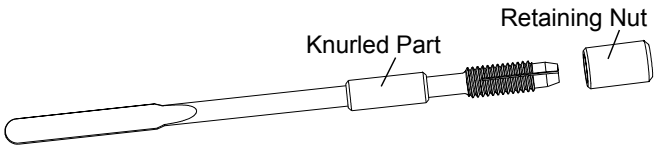
CAUTION:

When trying to pull out the bar, concentrate your force in the direction of the axis on the bar arm. Biased force may damage the bar and/or the axis.

Pinch the bar by the knurled part with one hand and unscrew (counter-clockwise) the retaining nut with the other hand until the mixing bar looses. Pull the bar downward to remove it and remove the nut.



4 Align the new mixing bar to the bigger hole end of the retaining nut and gently screw it into the nut until the end of the bar is in line with the smaller hole end of the nut.



5 Pinch the mixing bar by the knurled part and align the hole of the nut to the axis on the bar arm, then push the bar upward in the direction of the axis until it can't proceed. Tighten the nut by screwing clockwise with the other hand.

CAUTION:

When trying to push the bar, concentrate your force in the direction of the axis on the bar arm. Biased force may damage the bar and/or the axis.

Ensure the bar is all the way pushed to the end.

6 After replacing the bar, visually check whether the bar is vertical to the bar arm.

If not, remove the bar and re-install it.

If so, proceed to the next step.

7 Pull the bar arm to its highest point and rotate it to move the bar to a position above its wash well.

6.2.4 Replacing Plunger Assembly of Syringe

The old plunger assembly of syringe should be replaced with a new one when

- The old one has served for three months; or
- The old one has been used for over 100,000 tests; or
- The old one is apparently damaged.

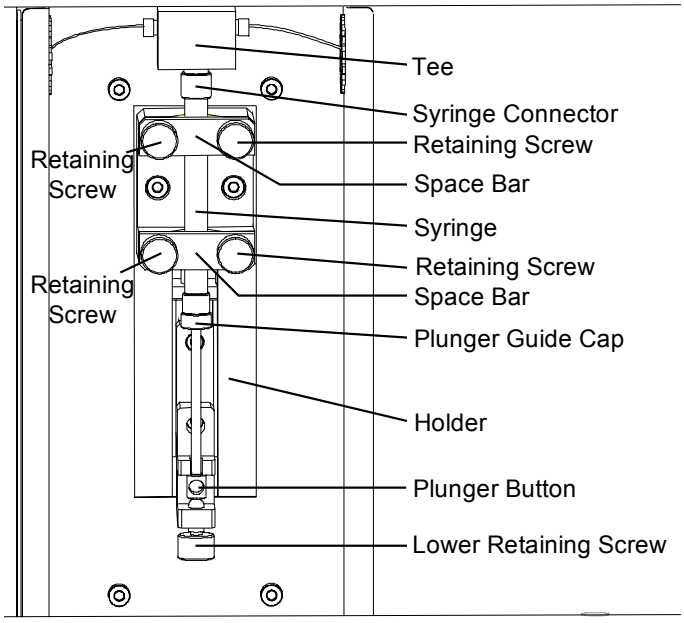
CAUTION:

Exercise caution when installing the assembly. Excessive force may crack the syringe.

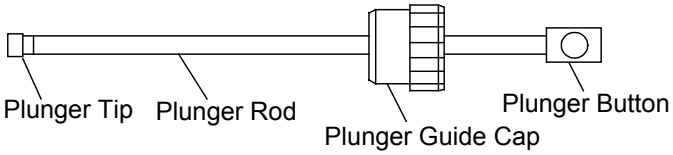
1 Place the Power to OFF.

2 Unscrew the screws on the syringe cover and remove the cover.

The structure of the syringe is as shown in the figure below.



3 Prepare a new plunger assembly (shown in the figure below) and soak the plunger tip in deionized water to eliminate bubbles.



4 Unscrew (counter-clockwise) the lower retaining screw.

5 Unscrew (counter-clockwise) the four retaining screws, remove the screws and space bars, and remove the syringe from the holder.

6

CAUTION:

There may be residual water in the syringe connector. Do not drop water onto the analyzing unit.

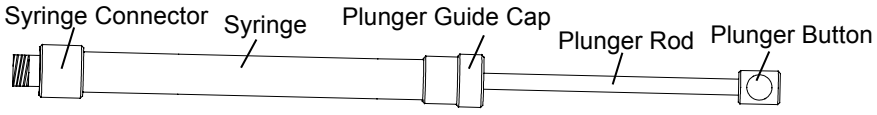
Grab the Tee with one hand and the syringe connector with the other hand and unscrew (counter-clockwise) the syringe.

7

CAUTION:

There may be residual water in the syringe. Do not drop water onto the analyzing unit.

Unscrew (counter-clockwise) the plunger guide cap and pinch the plunger button to gently pull the plunger assembly from the syringe.



8 Pinch the new plunger assembly by the plunger button and carefully insert the plunger tip into the syringe and push it all the way to the end. Screw (clockwise) the plunger guide cap until secure.

9 Immerse the syringe connector into deionized water. Pinch the plunger button, pull it to aspirate half syringe of deionized water and then push it to expel the deionized water and the air from the syringe.

10 Grab the Tee with one hand and the syringe connector with the other hand. Screw (clockwise) the syringe into the Tee until secure.

11 Place the syringe on the holder. Install space bars and fix retaining screws.

NOTE:

The upper edge of the upper space bar must reach the seventh line of the scale on the syringe.

When fixing retaining screws, be sure to tighten them alternately with equilibrium force.

12 Screw (clockwise) the lower retaining screw until secure.

13 Place the Power back to ON.

14 Enter the ***Commission*** screen of the system software and set the ***Vol.(Reagent Syringe)*** to 450. Click ***Reag. Syr. Aspirates***. After the syringe finishes the motion, click ***Reag. Syr. Dispenses***. You may repeat this action several times.

Pay attention to bubbles during the aspiration/dispensing process.

If there are bubbles observed during the process, they may be caused by the air leak between the syringe and the Tee. Uninstall the syringe and re-install it.

If the bubbles are found again, there is something wrong with the fluid path.

6.2.5 Replacing Lamp

Replace the lamp with a new one when the system reminds to do so, or the service time of the lamp has added up to 1,000 hours.

CAUTION:

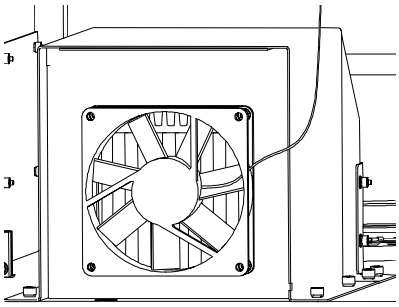
Do not touch either the light entrance of the lamp or the lens in front of the lamp. In case the entrance is dirty, clean it with ethanol-soaked defatted cotton.

1 Place the MAIN POWER to OFF. Wait at least 30 minutes for the lamp and its housing to cool down.

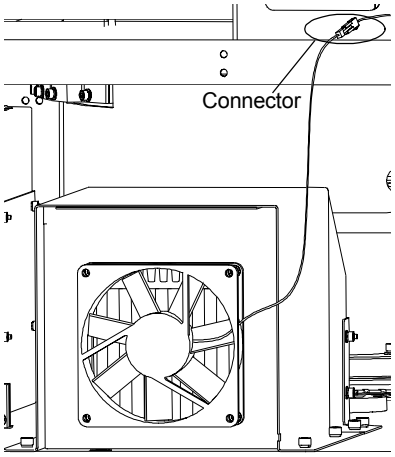
WARNING:

After working for a while, the lamp and its housing are usually hot enough to burn you. Do not proceed with this procedure until they have cooled down.

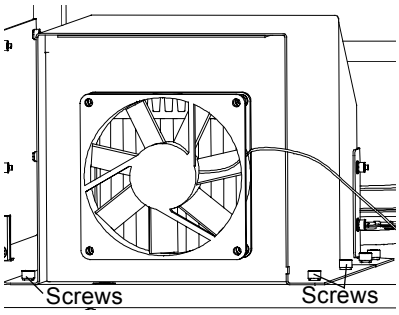
2 Unscrew the retaining screws on the back cover of the analyzing unit and remove the back cover. You can see the following box in the left lower part of the cabinet, where the lamp housing locates.



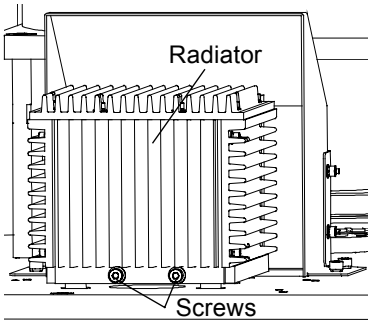
3 Unplug the connector of the wire.



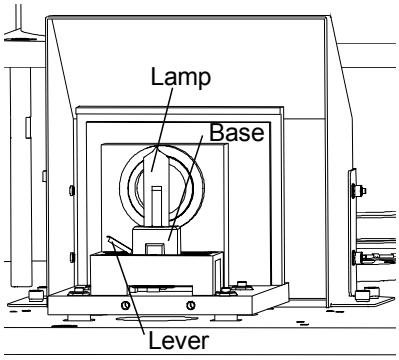
4 Unscrew the screws on the box with a hex wrench and remove the cover (together with the fan) backwardly.



5 Unscrew the screws on the back of the lamp housing with a hex wrench and remove the radiator from the housing backwardly.



6 Pinch the base of the lamp with one hand and press the lever on the left of the base and remove the lamp.



7 Pinch the new lamp by its base and insert the lamp pins into the mounting holes.

NOTE:

The larger pin is inserted into the larger hole and the smaller pin into the smaller hole.

8 Install the radiator back to the home position and tighten the screws.

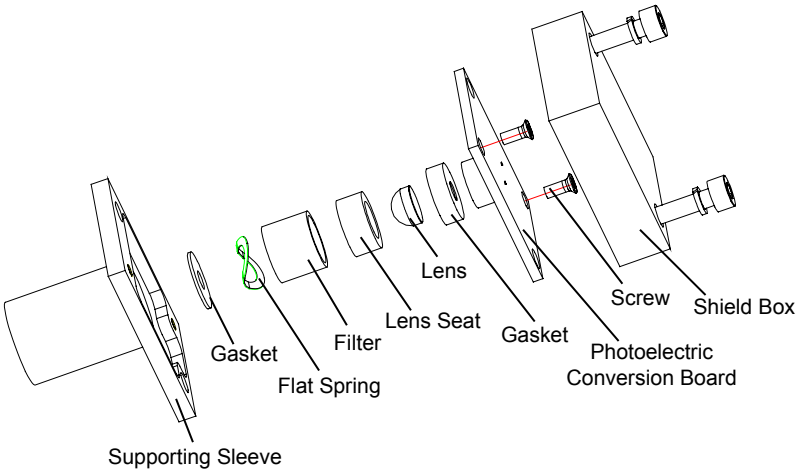
9 Install the cover back to the box and tighten the screws.

10 Close the back cover of the analyzing unit and tighten the screws.

6.2.6 Replacing the Filter Assembly

The filter and optical assembly are fixed in the supporting sleeve. The back end is compacted and enclosed with the photoelectric conversion board and the shielding cover (See Figure 6-1). Generally, the supporting sleeve is also replaced when service engineers replace the filter and optical assembly on the spot.

Figure 6-1 Filter assembly

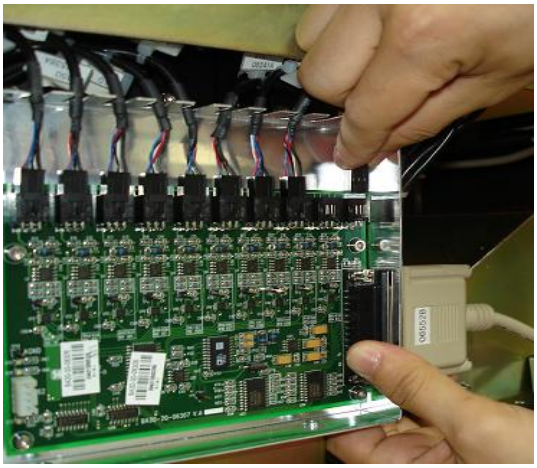


1 Place the MAIN POWER to OFF.

2 Remove the right plate of the analyzing unit.

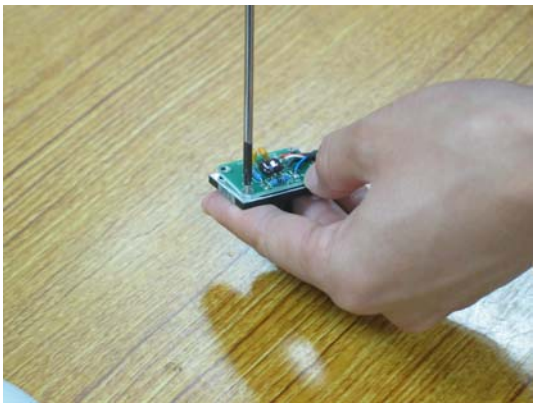
3 Use a hex wrench to unscrew the two screws on the shielding cover through the holes on the right frame.

4 Open the cover of the A/D conversion board, and remove the photoelectric conversion board plug of corresponding wavelength.

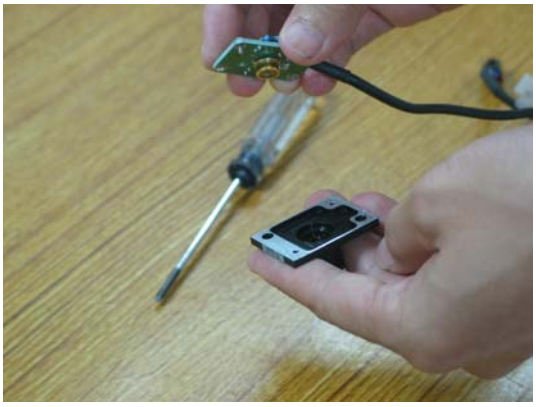


5 Remove the photoelectric conversion board and the supporting sleeve.

6 Keep the photoelectric conversion board upward, and remove the two retaining screws on it.



7 Keep the photoelectric conversion board upward, and then pull it out of the supporting sleeve.



8 Unpack the new supporting sleeve containing the optical assembly. Be sure to keep the sleeve upward.

9 Install the original photoelectric conversion board onto the new supporting sleeve, and then fasten the two retaining screws.

10 Install the shielding cover, and fix the retaining screws.

11 Connect the photoelectric conversion board to the AD conversion board, and then put back the cover.

NOTE:

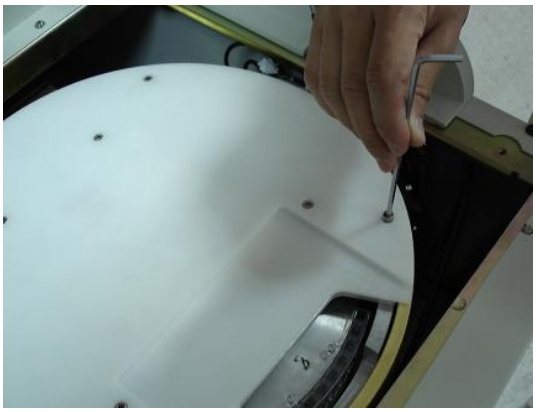
When replacing the filter assembly, do not touch the optical assembly in the supporting sleeve or the photodiode on the photoelectric conversion board.

The filters and the photoelectric conversion boards correspond to each other and should not be disarranged.

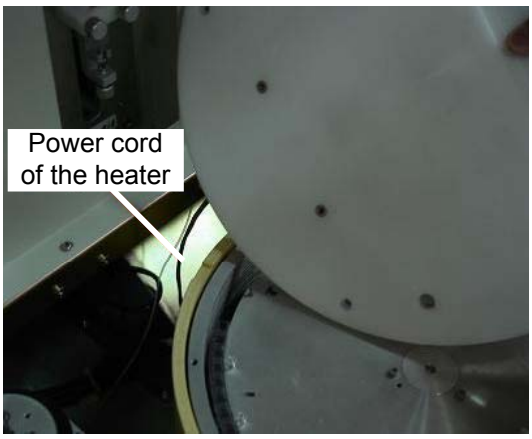
6.2.7 Replacing the Optical Fiber

1 Place the MAIN POWER to OFF.

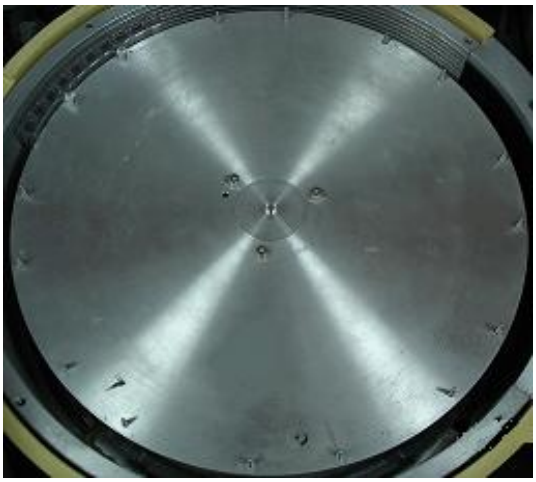
2 Unscrew the four screws on the reaction disk cover.



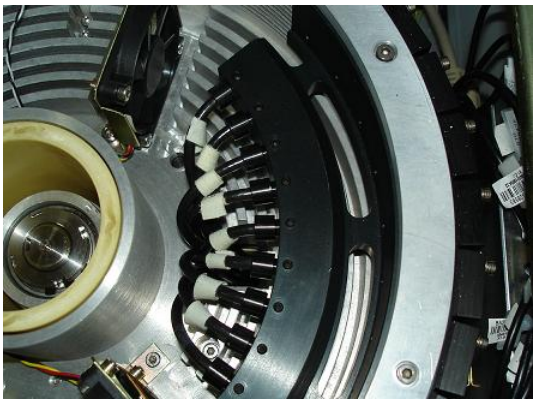
3 Open the reaction disk cover. Pay attention to the power cord of the heater.



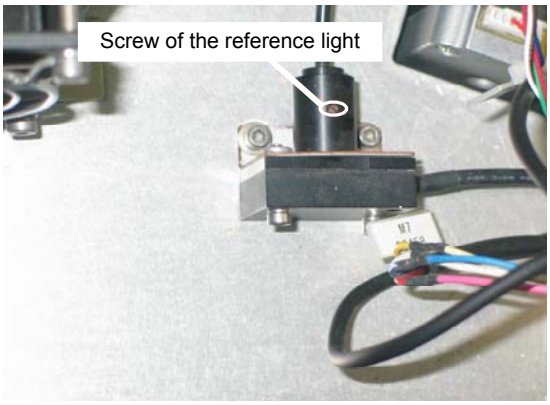
4 Remove the three M3 socket screws and take out the reaction disk.



5 Use a hex wrench to loosen the screws that are used to fasten the optical fibers on the colorimetric rack and the reference light support.

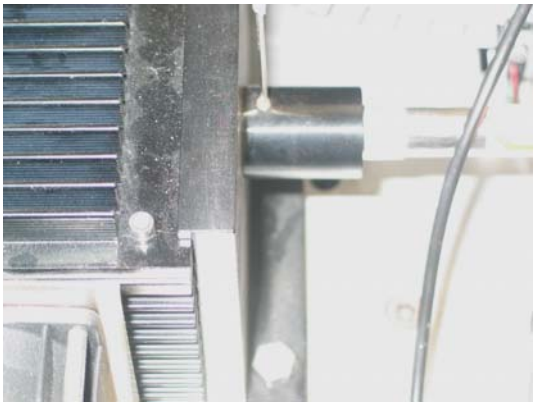


6 Take out the optical fibers one by one, and fix the optical components in the colorimetric rack by fastening the screws slightly.



7 Draw out the optical fibers from the bottom of the reaction compartment.

8 Loosen the M3 screw (used to retain optical fiber) on the lamp housing, and then draw out the optical fiber.



9 Put 9 of the 10 new optical fibers into the reaction disk through its bottom one by one, loosen corresponding screws, insert the optical fiber to the end, and then fasten the screws.

10 Loosen the screw of the reference light optical fiber, insert the optical fiber, and then fasten the screw.

11 Loosen the screw of the lamp housing, insert the optical fiber, and then fasten the screw.

12 Put back the reaction disk and fix it.

13 Put back the reaction disk cover and fix it.

NOTE:

When replacing the optical fiber, ensure that its bending radius is no less than 20cm, or the fiber will be damaged.

6.3 Adjusting

6.3.1 Adjusting Probe and Disks

NOTE:

Adjust the position of the probe according to the position of the cuvette first, and then adjust other positions.

Before adjusting parameters at the **PARA and Speed** tab of the **Maintenance and Test Software**, remember to click the **Enable modifying parameters** button at the **Command → Main Unit** tab and use a jumper to shortcut the 3.3V of J1 of the main control board; after finishing adjusting, remember to use a jumper to shortcut GND of J1 of the main control board.

1 Adjust the position of the probe.

NOTE:

To minimize cumulative errors, ensure that the probe returns to the initial position before each adjustment.

(1) Adjust the dispensing position of the probe. Ensure the probe is in the center of the cuvette and the probe tip is 2-3mm away from the top of the cuvette.

(2) Adjust the position of the initial-position transducer of the sample/reagent disk. Ensure the reagent bottles and sample tubes fit the disk cover well.

(3) Adjust the washing position of the probe. Ensure the probe is in the center of the wash well and the probe tip is 5mm away from the bottom of the wash well. If necessary, adjust the position of the wash well.

(4) Adjust the probe's position on the outer circle of the disk. Ensure the probe is in the center of the sample tube.

(5) Adjust the probe's position on the inner circle of the disk. Ensure the probe is in the center of the reagent bottle.

2 Adjust the position of the mixing bar.

(1) Adjust the mixing position of the bar. Ensure the bar is in the center of the cuvette on the reaction disk.

(2) Adjust the vertical position of the bar in the cuvette. Ensure the bar tip is 1-2mm away from the bottom of the cuvette.

(3) Adjust the washing position of the mixing bar. Ensure the bar is in the center of the wash well and about 5mm away from the bottom of the wash well. If necessary, adjust the position of the wash well.

3 In the **Maintenance and Test Software**, select corresponding command to rotate the reaction disk and move the probe and the mixing bar to see if they clash with any reaction cuvette. If the mixing bar knocks the side or the bottom of any cuvette, repeat Step 2.

6.3.2 Adjusting Signal Gain of Photoelectric Unit

1 Start the **Maintenance and Test Software**.

2 Select **Command** → **Main Unit** tab.

3 Click the **Enable modifying parameters** button.

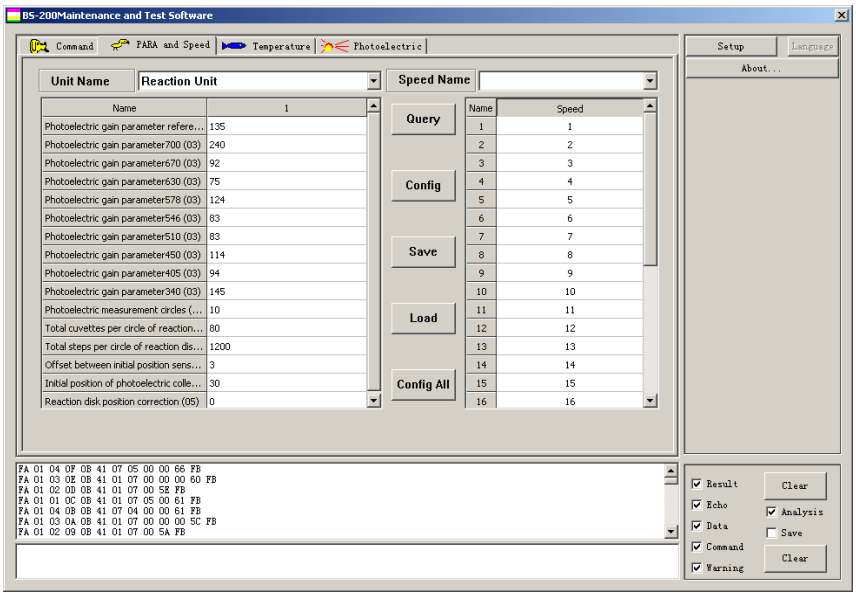
4 Select **Command** → **Reaction Unit** tab.

5 Click the **Turn on light** button to turn on the lamp of photoelectric unit.

6 Select **PARA and Speed** tab.

7 Select the **Reaction Unit** from the pulldown list to the right of **Unit Name**.

8 Click the **Query** button to display the photoelectric gain of each wavelength.



9 Ensure there is no cuvette on the reaction disk.

10 Adjust and configure the photoelectric gain of each wavelength (except 700nm) at the **PARA and Speed** screen until the voltage of each wavelength before A/D conversion is between 4.70V and 4.90V. You can measure the voltage of each wavelength on the A/D conversion board with a multimeter.

NOTE:

Before adjusting, remember to use a jumper to shortcut the 3.3V of J1 of the main control board.

After finishing adjusting, remember to use a jumper to shortcut GND of J1 of the main control board.

The following table displays the corresponding test points on the A/D conversion board (the reference test point is TP12).

Wavelength	340	405	450	510	546	578	630	670	REF
Test Point	TP1	TP2	TP3	TP4	TP5	TP6	TP7	TP8	TP10

6.3.3 Adjusting Photoelectric Collection Position

1 Start the **Maintenance and Test Software**.

2 Select **Command** → **Main Unit**.

3 Click the **Enable modifying parameters** button.

4 Click the **Mechanical Reset** button to reset all the mechanical parts of the analyzer.

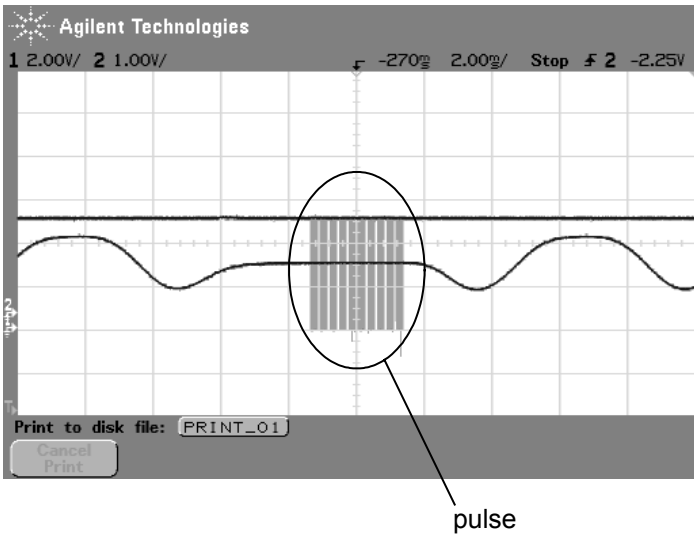
5 Place 8 segments of new cuvettes in the reaction disk.

6 Measure the TP1 with a dual trace oscillograph. The reference test point is TP12.

7 Select **Command → Reaction Unit**.

8 Click the **Rotate and Measure** button and observe the positions of the pulses relative to the waveform from the oscillograph.

All pulses should be generated at the flat parts of the waveform and most of them should be at a little right of the center of the flat parts, as shown in the figure below.



9 If the positions of the pulses do not meet the above requirements, you can adjust the initial position of photoelectric collection according to the following steps.

(1) Select **PARA and Speed** tab of the **Maintenance and Test Software**.

(2) Select **Reaction Unit** from the pulldown list to the right of **Unit Name**.

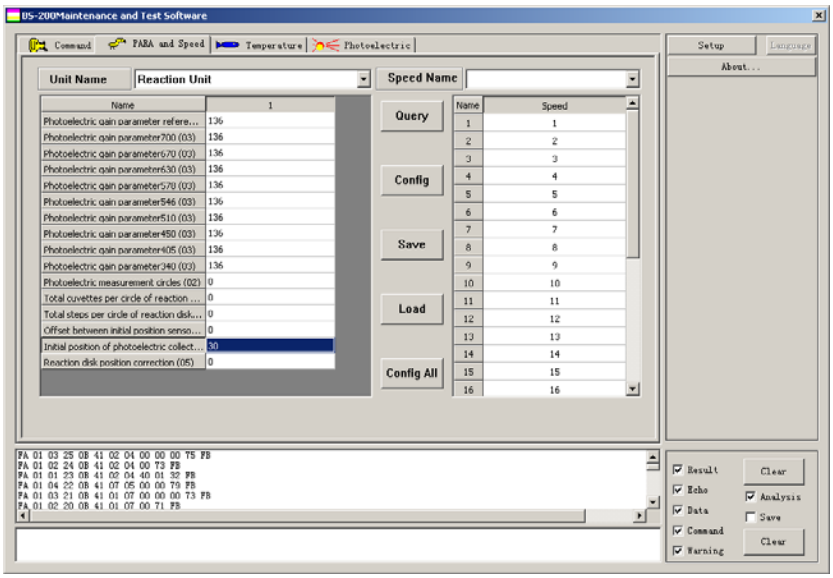
(3) Click the **Query** button.

(4) Adjust and configure the parameter of **Initial position of photoelectric collection** and go back to the step 2 (skip step 3).

NOTE:

Before adjusting, remember to use a jumper to shortcut the 3.3V of J1 of the main control board.

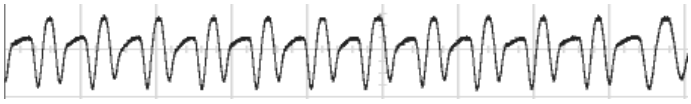
After finishing adjusting, remember to use a jumper to shortcut GND of J1 of the main control board.

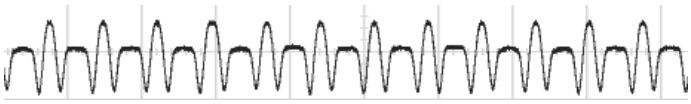


10 Repeat through step 2 to step 9 (except step3) to measure the waveform of other wavelengths whose test points are from TP2 to TP10 (except TP9).

NOTE:

(1) If the waveform is oblique, as shown in the figure below, loosen the screw that is used to fasten the optical fiber on the colorimetric rack or the reference light support and rotate the fiber slightly (avoiding breaking the fiber) until the waveform is not oblique. After adjusting, fasten the screw.


oblique


not oblique

(2) The parameter of **Initial position of photoelectric collection** cannot be less than 0. If it is 0 and the pulses still cannot meet requirements, you need to adjust the optical coupler of the reaction unit that is used to detect the position of the reaction disk.

6.4 Checking

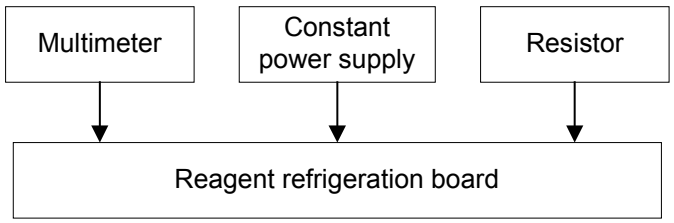
6.4.1 Checking Reagent Refrigeration Board

■ Test Device

1. A multimeter
2. A constant power supply
3. A resistor
4. 4 jumpers

5. A slotted screwdriver (2mm)

■ Connection Diagram



■ Checking Procedure

1. To test the power supply

Connect the constant power supply to J86 (PIN 1, 5, 6 to 12V; PIN 2, 3, 4 to GND) and J87 (PIN3 to +5V; PIN1 to GND). Use the multimeter to check the constant power supply (12V±0.6V and 5V±0.3V). Power on the constant power supply and check the power supply as following:

1 9V: 9±0.45V; test point: the voltage at two terminals of the C2 capacitor.

2 5FAN: 5±0.25V; test point: the voltage at two terminals of the C14 capacitor.

3 5V: 5±0.25V; test point: the voltage at two terminals of the C16 capacitor.

4 2.5V: 5±0.25V; test point: the voltage at two terminals of the C7 capacitor.

2. To adjust the temperature control point

Adjust VR1 to make the TP1 (TP3: GND): 1.75V±0.01V.

Adjust VR2 to make the TP2 (TP3: GND): 1.84V±0.01V.

After adjustment, fix the resistance of VR1 and VR2 with a little glue or other materials.

3. To adjust the temperature control

Connect a resistor to the slot of the J88 transducer and adjust the resistance to simulate the variation of temperature.

Adjust the resistor to make TP5 (TP3: GND) supply switch between 1.85V (reference resistance of resistor is 12.5K) and 1.75V (reference resistance of resistor is 10.2K) and measure the voltage at 1 and 2 terminals of the J89.

1) If the TP5 supply is more than 1.84V, the output is 0V±0.6V.

2) If the TP5 supply decreases from 1.84V, the output doesn't change. If it is no more than 1.75V, the output is 12V±0.6V.

3) If the TP5 supply increases from 1.75V, the output doesn't change. If it is no less than 1.84V, the output is 0V±0.6V.

4. Test the feedback signals of fans

When no fan is connected to J71-J74, LED1-LED4 light and the U6 PIN4 (TP3: GND) has a high level (>4V).

When PIN1 and PIN2 of any of the J71-J74 are short circuited with a jumper, the corresponding LEDs are off and the U6 PIN 4 has a high level (>4V).

When PIN1 and PIN2 of the J71-J74 are short circuited with jumpers, all LEDs are off and the U6 PIN 4 has a low level (<0.8V).

Temperature (℃)	2	3	4	5	6	7	8	9	10	11	12
Voltage (V)	1.88	1.86	1.84	1.82	1.79	1.77	1.75	1.73	1.7	1.68	1.66

6.4.2 Checking Optical Couplers

This procedure is applicable to all four-pin optical couplers used on the analyzer.

1 There are two labels E and S on the optical coupler. E stands for emitter and S stands for sensor.

2 A constant DC 5V or above is needed.

3 Usually the two pins on the E terminal are red and black or red and blue. The red end is for high level.

The E terminal that is powered by 5V is in serial connection with a 220Ω resistor.

4 Usually the two pins on the S terminal are white and green. The white end is for high level.

The S terminal that is powered by 5V is in serial connection with a 5.1KΩ resistor.

5 Voltage of the white end can be measured with a multimeter.

When the optical coupler is not shielded, the white end has a low level which does not exceed 0.6V; otherwise it has a high level which exceeds 4.4V.

If the measured voltage is within the above thresholds, the optical coupler runs normally.

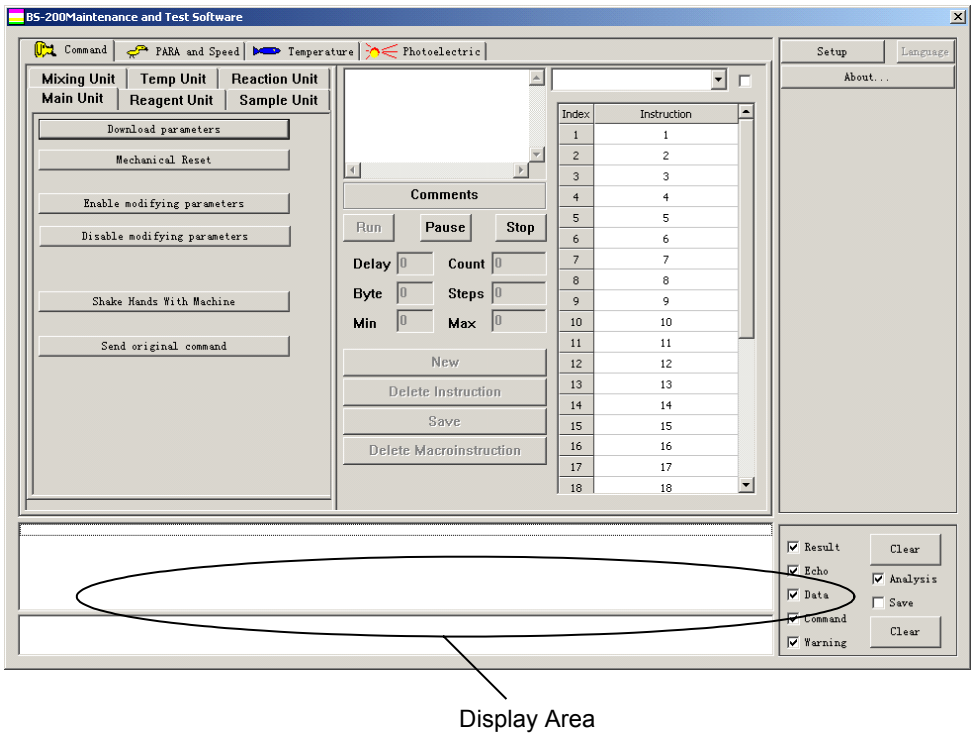
7 Maintenance and Test Software

7.1 General

The maintenance and test software of the BS-200 Chemistry Analyzer is the software that helps maintenance personnel debug and maintain the BS-200 Chemistry Analyzer. Maintenance personnel can, through this software, check whether the probe, mixing bar, disks, fluidic system and photometric system of the BS-200 Chemistry Analyzer work normally, modify parameters, and execute individual commands or combined commands.

Run the **NewDebug.exe** file to enter the **BS-200 Maintenance and Test Software** window. See Figure 7-1. After that, the software will connect to the analyzing unit automatically and then it can work. If there is any problem, you can click the **Shake Hands With Machine** button (at the **Command → Main Unit** screen) to connect the software to the analyzing unit.

Figure 7-1 **BS-200 Maintenance and Test Software** window



As shown in Figure 7-1, there are 4 tabs in the **BS-200 Maintenance and Test Software** window:

- **Command**;
- **PARA and Speed**;
- **Temperature**;

- **Photoelectric**.

CAUTION:

It is suggested that if you click a button to send an instruction to the analyzing unit, you can click another one only after the previous instruction is executed.

Note:

The buttons displayed in gray in software interface are not functional.

Following is a brief introduction to the software interface.

- Display area

At the bottom of the window is the display area for displaying the frame information and fault/error information. The upper box is for frame information, and the lower one is for fault/error information.

There are five types of frame information, including **Result**, **Echo**, **Data**, **Command** and **Warning**.

Select the check box in front of frame information to display relevant frame information. Click the check box again to de-select, and the frame information will not be displayed.

If you select the check box in front of **Analysis**, the complex **Result** and **Warning** frame information that contains information of several different parts will be split and displayed at the display area.

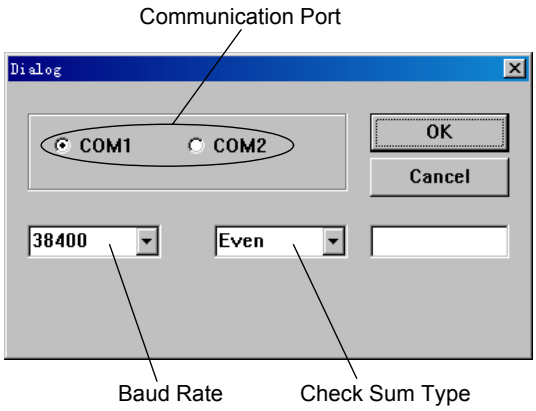
If you select the check box in front of **Save**, all the sent and received frame information and fault/error information will be saved in a .txt file that locates in the D:\FrameSaveFile.

Click the **Clear** button to clear the information that displayed in relevant box. The two **Clear** buttons are respectively for two boxes.

- **Setup** button

Click the **Setup** button at up right corner to show a dialog as shown in Figure 7-2, which is used to change communication port and set baud rate and check sum type of the port. Check sum type includes odd, even and none.

Figure 7-2 Serial Port Setup



- **About…** button

Clicking the **About…** button at up right corner of the interface, you can view the version information of this software.

In the following sections, the 4 tabs mentioned above will be detailed respectively.

Note:

The units of parameters involved in this software are respectively:

Time: 50ms;

Sample (reagent) aspirating/dispensing volume: steps of motors;

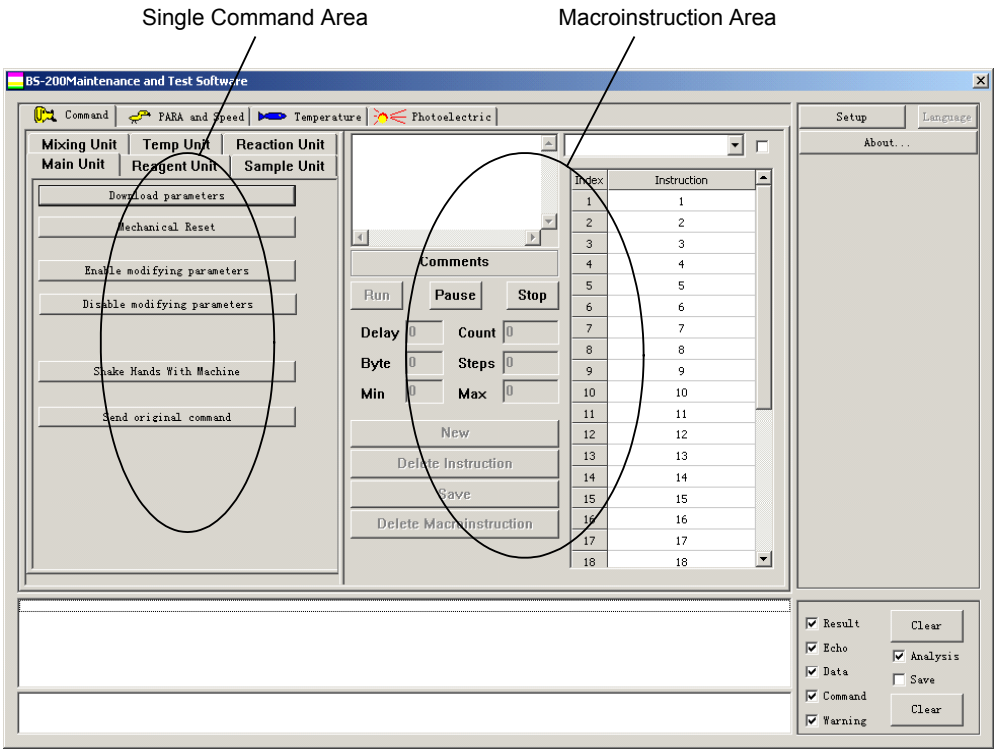
Temperature: ℃.

Temperature control coefficient: 0.01.

7.2 Command

In the **Command** tab, you can send commands to the BS-200 Chemistry Analyzer and check whether probe, mixing bar, disks, fluidic system and photometric system work normally.

Figure 7-3 **Command** tab



As shown in Figure 7-3, the **Command** tab mainly consists of two parts: Single Command Area and Macroinstruction Area.

7.2.1 Single Command Area

In Single Command Area, there are 6 sub-tabs:

- **Main Unit**;
- **Reagent Unit**;
- **Sample Unit**;
- **Mixing Unit**;
- **Temp Unit**;
- **Reaction Unit**.

Check the analyzing unit for their counterparts.

There are several buttons in each tab. Click a button and you can send a command to the counterpart on the analyzing unit.

Note:

After starting this software, you must click the **Down Load Parameters To Machine** button in the **Main Unit** sub-tab. Otherwise, the software will not operate the analyzing unit successfully.

After clicking the **Enable modify parameter** button in the **Main Unit** sub-tab, you can modify the parameters and speeds in the **PARA and Speed** tab.

Following are instructions to the action implemented by each command.

- **Main Unit**

Command	What it does
Download parameters	Configures running parameters for the analyzing unit.
Mechanical Reset	Moves all units of the analyzing unit to their initial position, and cleans reagent probe, sample probe and mixing bar.
Enable modifying parameters	Switches on the switch for modifying parameter through this operation before modifying parameter at **PARA and Speed** tab.
Disable modifying parameter	Switches off the switch for modifying parameter through this operation after modifying parameter at **PARA and Speed** tab.
Shake Hands With Machine	Checks that the communication cable works normally.
Send original command	Edits and sends user-defined commands.

- **Reagent Unit**

Command	What it does
Reagent probe wash	Cleans the reagent probe.
Reagent probe to the top of reaction tray	Moves the reagent probe to the top of reaction disk.
Reagent probe to the outer of reagent tray	Moves the reagent probe to the top of the outer circle of reagent disk.
Reagent probe to the inner of reagent tray	Moves the reagent probe to the top of the inner circle of reagent disk.
Reagent probe down to the outer of reagent tray	Moves the reagent probe down to the reagent bottle in the outer circle of reagent disk.

Command	What it does
Reagent probe down to the inner of reagent tray	Moves the reagent probe down to the reagent bottle in the inner circle reagent disk.
Reagent probe down to reaction tray	Moves the reagent probe down to the reaction cuvette in the reaction disk.
Reagent probe down to wash pool	Moves the reagent probe to its washing position.
Reagent probe move to top of wash pool	Moves the reagent probe to the top of wash pool.
Reagent tray rotate	Rotates the reagent disk for specified circles and stop it at specified bottle position. Input rotating circles in the first box and position No. in the second box.
Reagent tray rotate to cup	Rotates the reagent disk to specified bottle position. Input position No. in the box.
Reagent syringe init	Moves the reagent syringe to its initial position.
Reagent syringe full	Moves the reagent syringe to its largest travel.
Reagent syringe empty	Empties the reagent syringe.
Reagent probe position correct	The probe dispenses 180 μl of water to the No.1-No.10 cuvettes separately and then moves into the cuvettes to detect the fluid level. You can click the **Stop** button to stop the motion. After the motion is finished, the box to the right of the button displays the average steps of probe motor.
Reagent unit reset	Cleans the reagent probe and rotates the reagent disk to position No. 1.

■ **Sample Unit**

Command	What it does
Sample probe wash	Cleans the sample probe.
Sample probe to the top of wash pool	Moves the sample probe to the top of wash pool.
Sample probe to the top of reaction tray	Moves the sample probe to the top of reaction disk.
Sample probe to the inner of sample tray	Moves the sample probe to the top of the inner circle of sample disk.
Sample probe to the outer of sample tray	Moves the sample probe to the top of the outer circle of sample disk.

Command	What it does
Sample probe down to reaction tray	Moves the sample probe down to the reaction cuvette in reaction disk.
Sample probe down to washing pool	Moves the sample probe to its washing position.
Sample probe down to outer of sample tray	Moves the sample probe down to the tube in the outer circle of sample disk.
Sample probe down to inner of sample tray	Moves the sample probe down to the tube in the inner circle of sample disk.
Sample tray rotate	Rotates the sample disk for specified circles and stop it at specified tube position. Input rotating circles in the first box and position No. in the second box.
Sample tray rotate to cup	Rotates the sample disk to specified tube position. Input position No. in the box.
Sample syringe init	Moves the sample syringe to its initial position.
Sample syringe empty	Empties the sample syringe.
Sample syringe full	Moves the sample syringe to its largest travel.
Sample unit reset	Cleans the sample probe and rotate the sample disk to position No. 1.

- **Mixing Unit**

Command	What it does
Mixing bar to the top of wash pool	Moves the mixing bar to the top of the wash pool.
Mixing bar into wash pool	Moves the mixing bar into the wash pool.
Mixing bar to the top of reaction tray	Moves the mixing bar to the top of reaction disk.
Mixing bar into reaction tray	Moves the mixing bar to mixing position in reaction disk.
Mixing bar stirs for given time	Mixing bar stirs for a specified period.
Mixing unit reset	Resets all the mechanical parts of the mixing unit.

- **Temp Unit**

Command	What it does
Enable/Disable temperature control	Turns on/off the specified temperature controller. There're two temperature controllers as **Reaction** and **Reagent**. Selects the check box in front of a controller, click the button, you can turn on the selected controller with unselected one off.

To calculate coefficients of temperature sensor

1 If you want to modify the parameters of the sensor line, click **Modify** button at the **Length of Sensor Line** field;

Otherwise, go directly to the step 3.

2 Enter values into the **Original(cm)** and **Added(cm)** edit boxes, and click **OK** button.

3 Enter values into the edit boxes at the **Original Data** field.

Or, if you want to get the default values, click the **Default** button.

4 Click the **Calculate** button to calculate the coefficients.

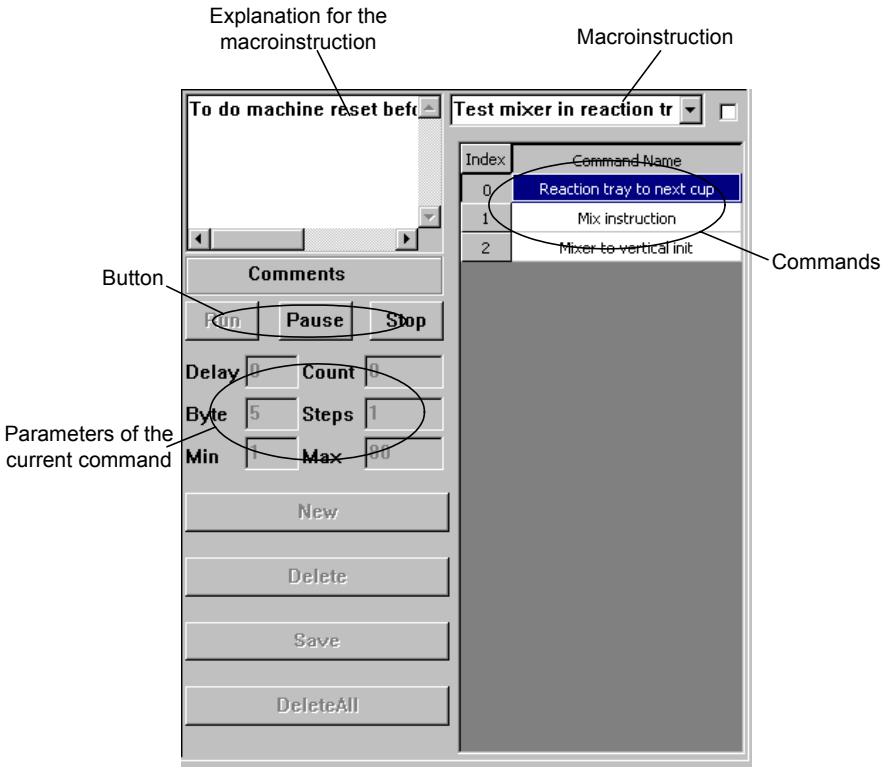
- **Reaction Unit**

Command	What it does
Reaction tray rotate	Rotates the reaction disk for specified circles and stop it at specified cuvette position. Input rotating circles in the first box and position No. in the second box.
Reaction tray rotate some cups	Rotates the reaction disk for specified cuvette positions, and input number of cups in the box.
Rotate and measure	Rotates the reaction disk, collects reaction data during rotating, and then stops it at specified cuvette position.
Turn on light	Turns on the light.
Turn off light	Turns off the light.
Test dark current	Turns off the light and measures the dark current at this time. The dark current data will be displayed in the box below.

Command	What it does
Test base current of new lamp	Unloads the first segment of cuvettes in reaction disk with manipulator, then rotates the reaction disk and during rotating measures the light where places the first segment of cuvettes before. The data regarding base current will be displayed in the box below.
Test dark current	Tests dark current of every wavelength.
Test base current	Tests background of every wavelength.

7.2.2 Macroinstruction Area

Figure 7-4 Macroinstruction Area



A macroinstruction is a set of commands.

When selecting a macroinstruction from the pulldown list in macroinstruction area, you can see there're various commands and comments regarding the macroinstruction. In addition, parameters of the command currently selected will also be displayed on the interface.

Note:

Only the power user can create or delete macroinstructions. If you want to get the authority of the power user, contact Mindray Service Department.

In the macroinstruction area, after selecting a macroinstruction from the pulldown list, you can

- Click the **Run** button to run the selected macroinstruction;
- Click the **Pause** button to suspend the macroinstruction which is running;
- Click the **Stop** button to stop the macroinstruction which is running.

Note:

After all commands in each macroinstruction are executed, the system counts it as one time.

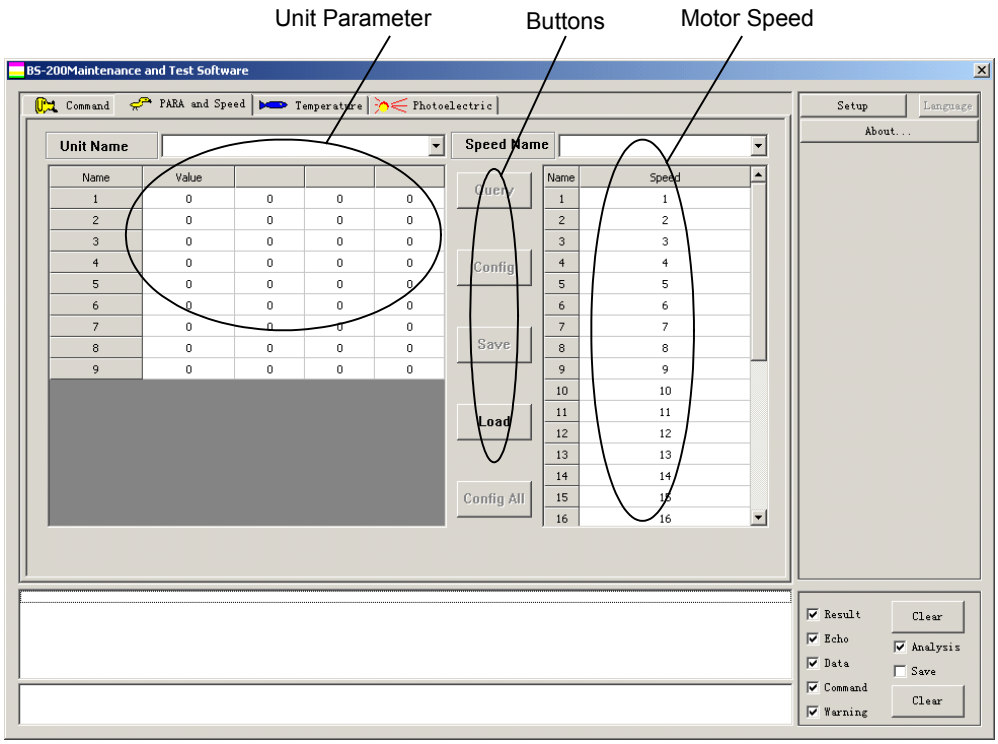
When the check box on the right of the macroinstruction pulldown list is selected, the selected macroinstruction will be executed for once; otherwise, the macroinstruction will be executed cyclically.

For each macroinstruction, the commands of it are executed one by one in the sequence in which they are listed. When the set delay expires after a command is executed, the next command is executed immediately. In case of an error in the execution process, the macroinstruction will be stopped.

7.3 PARA and Speed

In the **PARA and Speed** tab, you can query, configure or load parameters and motor speeds as well as debug the units and motors.

Figure 7-5 **PARA and Speed** tab



As shown in Figure 7-5, the **PARA and Speed** tab mainly consists of three parts as unit parameter, motor speed and several operating buttons.

Unit Name includes **Main Unit**, **Mixing Unit, Reaction Unit**, **Reagent Unit**, **Sample Unit** and **Temperature Unit**.

Following are instructions to each motor name.

Speed Name	Description
Mixing bar horizontal movement	The stepping motor that moves the mixing bar horizontally.
Mixing bar vertical movement	The stepping motor that moves the mixing bar vertically.
Reaction disk rotating motor	The stepping motor that rotates the reaction disk.
Reagent disk rotating motor	The stepping motor that rotates the reagent disk.
Reagent probe horizontal movement	The stepping motor that moves the reagent probe horizontally.
Reagent probe vertical movement	The stepping motor that moves the reagent probe vertically.
Reagent syringe movement motor	The stepping motor that moves the reagent syringe.
Sample disk rotating motor	The stepping motor that rotates the sample disk.

Speed Name	Description
Sample probe horizontal movement	The stepping motor that moves the sample probe horizontally.
Sample probe vertical movement	The stepping motor that moves the sample probe vertically.
Sample syringe movement motor	The stepping motor that moves the sample syringe.

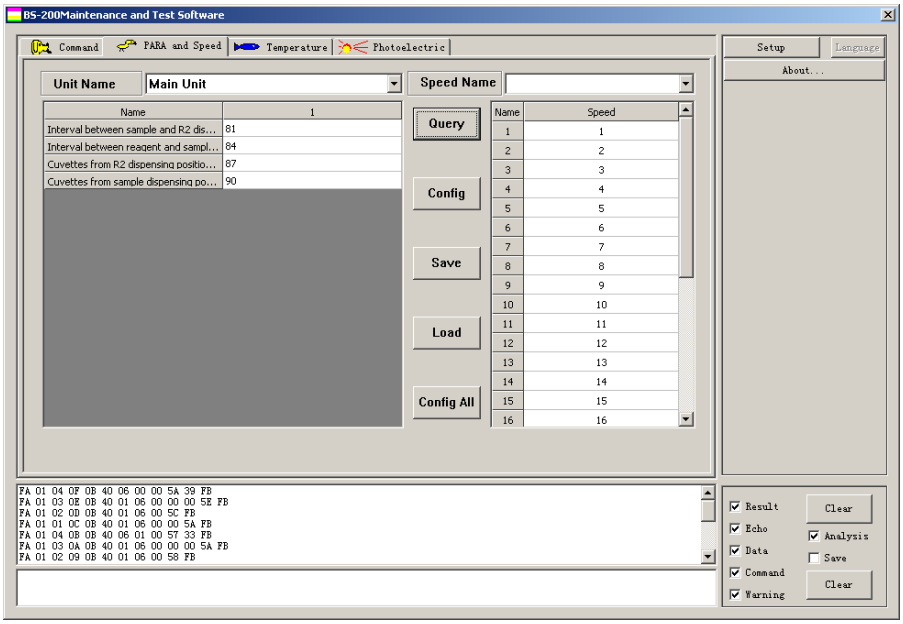
At this screen, you can not only inquire and configure each unit parameter and motor speed, but also save and read relevant data. Now let's introduce them respectively.

■ Inquire unit parameter or motor speed

1 Select a unit in **Unit Name** or a motor in **Speed Name**.

2 Click **Query** button.

For example.



■ Configure a parameter or speed for relevant unit or motor

1 Select a unit in **Unit Name** or a motor in **Speed Name**.

2 Click the **Query** button.

3 Edit the parameter or speed if necessary. Otherwise, go to the next step directly.

When editing, you can directly select and modify the data to be edited.

4 Select a parameter or speed to be configured. For example.

Name	1
Standard height for adding reagent	-6192
Reagent aspirating mode	112
Air volume after aspirating reagent	112
Air volume before aspirating reagent	112
Offset between initial disk position and coder	112
Content of reagent syringe	-6192
Vertical limit of reagent probe wash position	-6192
Cuvette position correction of reagent disk outer circle	112
Cuvette position correction of reagent disk inner circle	112
Reagent dispensing volume when washing exterior	-6192
Excess reagent volume	-6192
Air aspiration volume of reagent probe	-6192
Limit position of reagent probe reverse rotation	-6192
Limit position of reagent probe obverse rotation	-6192
Total cuvettes in outer circle of reagent disk	112
Total cuvettes in inner circle of reagent disk	112
Total steps per circle of reagent disk	-6192
Conversion coefficient from reagent volume to motor steps	-6192
Reagent probe wash time	112

5 Click the **Config** button to configure the parameter or speed for relevant unit or motor of the analyzing unit.

- Configure all parameters or speeds for relevant units

1 Select units in **Unit Name** or motors in **Speed Name**.

2 Click the **Config All** button to configure all parameters or speeds of the unit or motors selected for relevant units or motors of the analyzing unit.

- Save data

1 Select a unit in **Unit Name** or a motor in **Speed Name**.

2 Click the **Save** button, then pop up a dialog.

3 Input a filename and click the **Save** button, you can save parameter of the unit or motor currently selected to a .txt file.

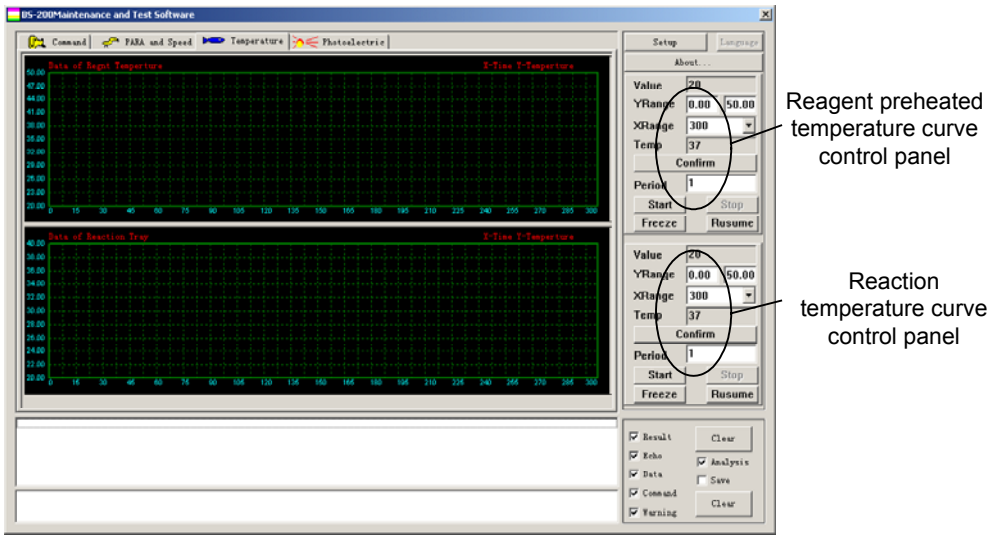
- Read Data

1 Click **Load** button, then pop up a dialog.

2 Select the relevant .txt file and click **Open** button, you can configure parameter or speed in the file for relevant unit or motor of the analyzing unit.

7.4 Temperature

Figure 7-1 **Temperature** tab



The **Temperature** tab consists of two parts:

- Curve of reagent preheated temperature (upper part);
- Curve of reaction temperature (lower part).

The two temperature curves are controlled respectively through two control panels on the right.

Meanings of the parameters on the control panels are as follows.

Parameter	What it does
Value	Displays current temperature value on the temperature curve.
YRange	Temperature range on Y-coordinate of the temperature curve. Input upper limit and lower limit of temperature range in the two boxes.
XRange	X-coordinate point of the temperature curve.
Temp	Intended temperature expected to achieve.
Period	Interval for sampling.

After setting **Xrange**, **Yrange** and **Temp** on the control panel, click **Confirm** button to implement them on relevant temperature curve.

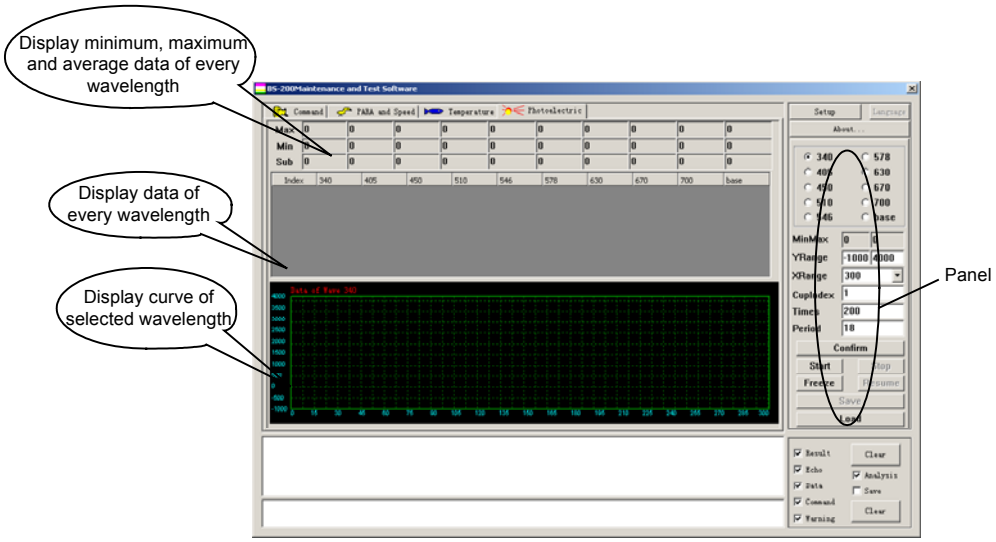
There are 4 more buttons in each of the two control panels:

- **Start**: After setting **Period**, clicking it, you can start collecting the temperature data;
- **Stop**: Clicking it, you can stop collecting the temperature data;
- **Freeze**: Clicking it, you can freeze the displayed curve;
- **Resume**: Clicking it, you can resume the frozen curve.

7.5 Photoelectric

In the **Photoelectric** tab, the values of photoelectric data and photoelectric data curve of the selected wavelength are displayed.

Figure 7-2 **Photoelectric** tab


Display minimum, maximum and average data of every wavelength
Display data of every wavelength
Display curve of selected wavelength
Panel

Through the panel, you can set relevant parameters of photoelectric test data and photoelectric curve.

Nine wavelengths (340, 405, 450, 510, 546, 578, 630, 670 and 700) and a base wavelength are listed on the panel. You can select one of them to display its photoelectric data curve.

Parameter	What it does
MinMax	Displays maximum and minimum for photoelectric data of the selected wavelength.
YRange	Range on the Y-coordinate of the curve. Input upper limit and lower limit for photoelectric data in the two boxes.
XRange	X-coordinate point of the curve.
CupIndex	Specifies the cuvette in certain position of reaction disk to be used to measure photoelectric data.
Times	Times of sampling.

Parameter	What it does
Period	Interval for sampling.

Through the panel, you can select parameters like wavelength, **YRange**, **XRange, CupIndex, Times** and **Period**.

After setting them, click the **Confirm** button to confirm the settings.

There are 6 more buttons in the panel:

- **Start**: Clicking it, you can start collecting the temperature data;
- **Stop**: Clicking it, you can stop collecting the temperature data;
- **Freeze**: Clicking it, you can freeze the displayed curve;
- **Resume**: Clicking it, you can resume the frozen curve;
- **Save**: Clicking it, you can save the photoelectric data of all current wavelengths as a .txt file;
- **Load**: Clicking it, you can read the data in a .txt file saved with photoelectric data.

Appendix A Diagrams

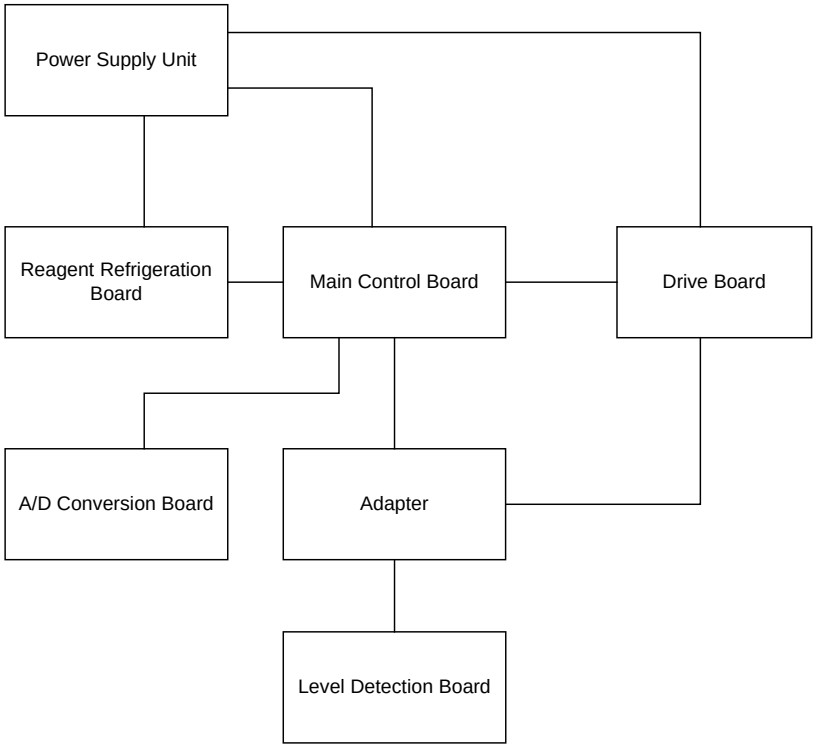


Figure A-1 Connection of Boards

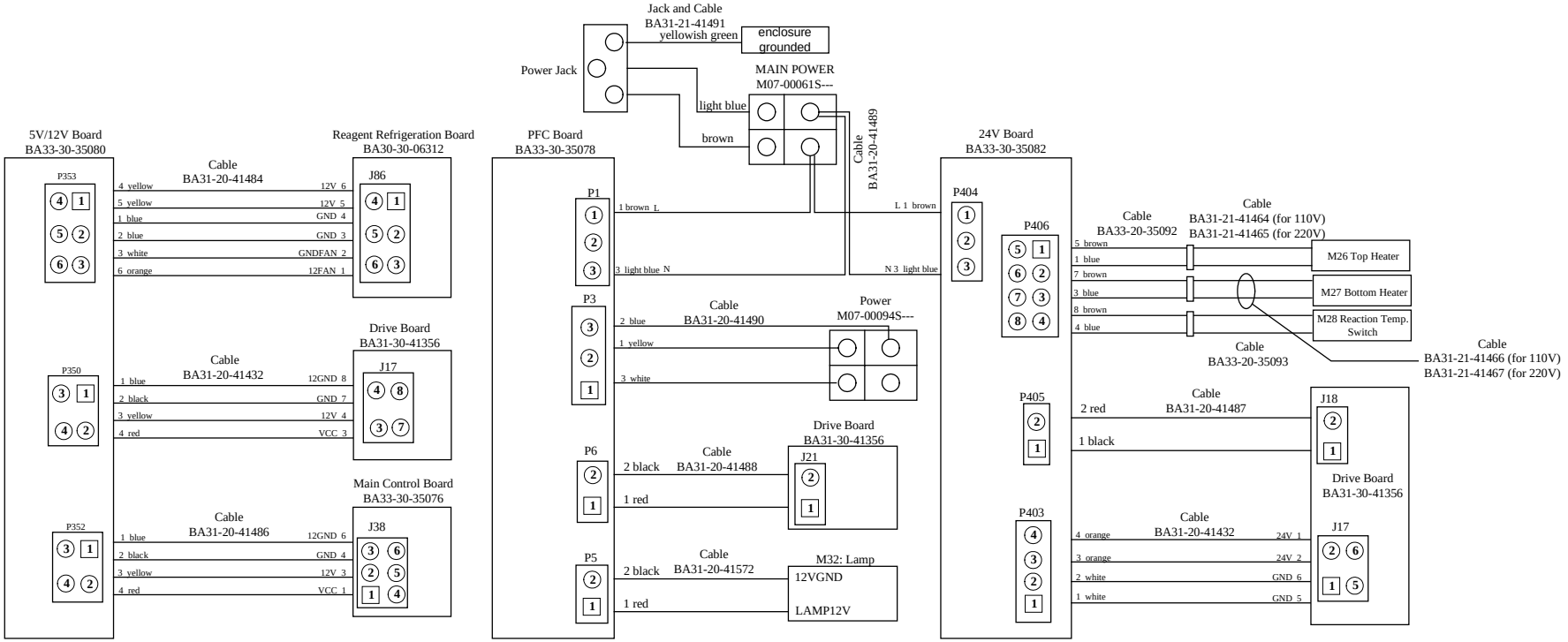


Figure A-2 Power Supply Unit

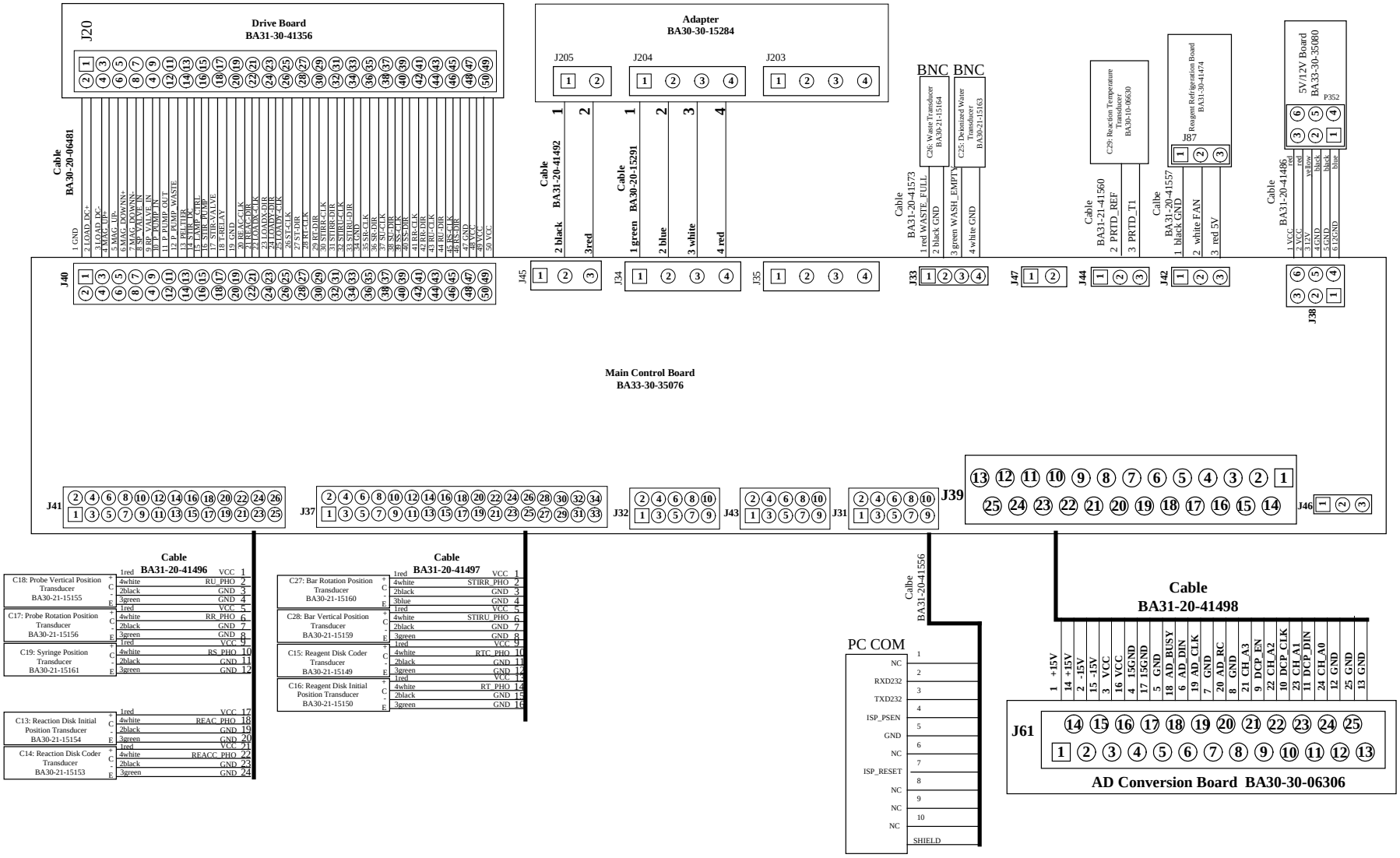


Figure A-3 Main Control Board

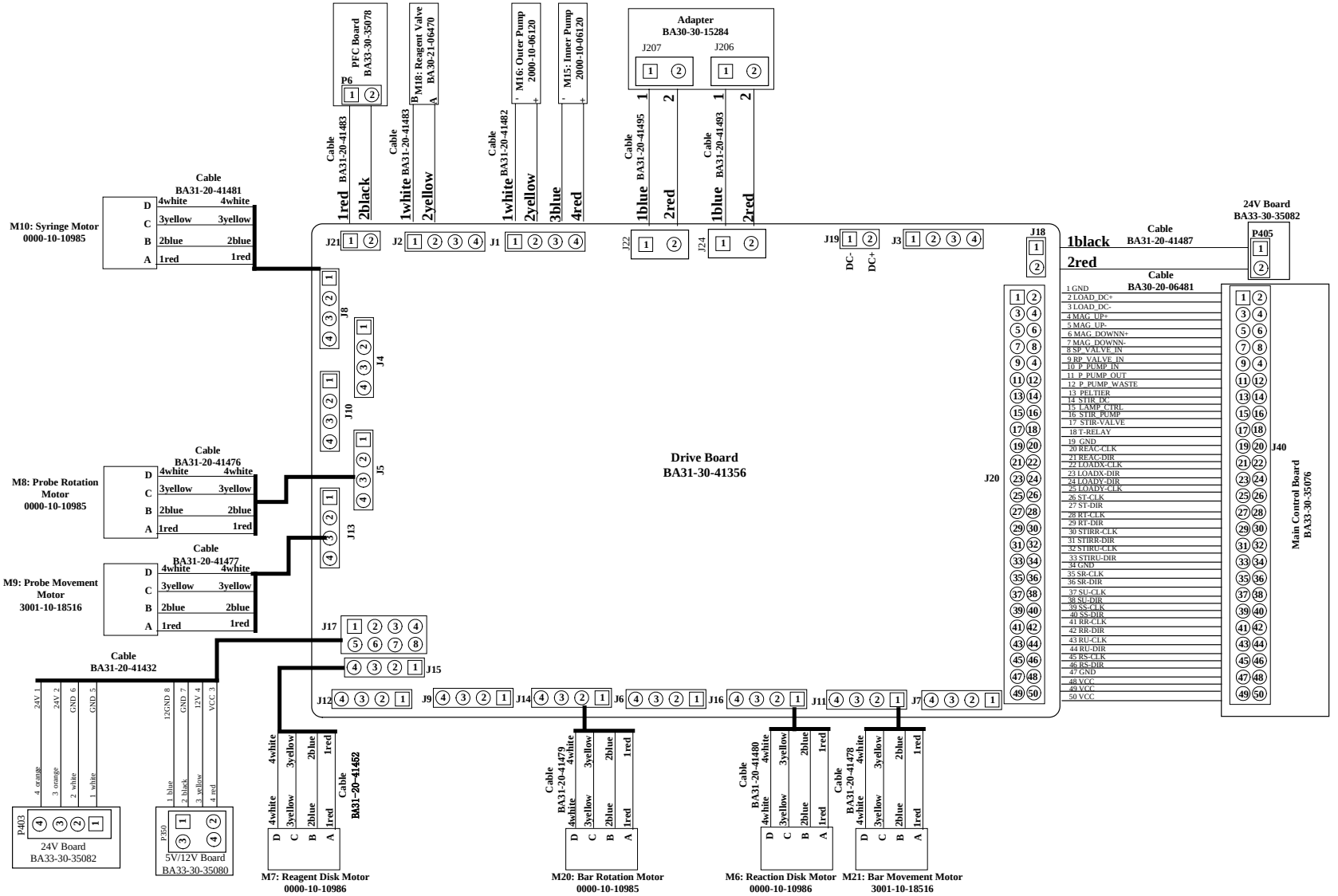


Figure A-4 Drive Board

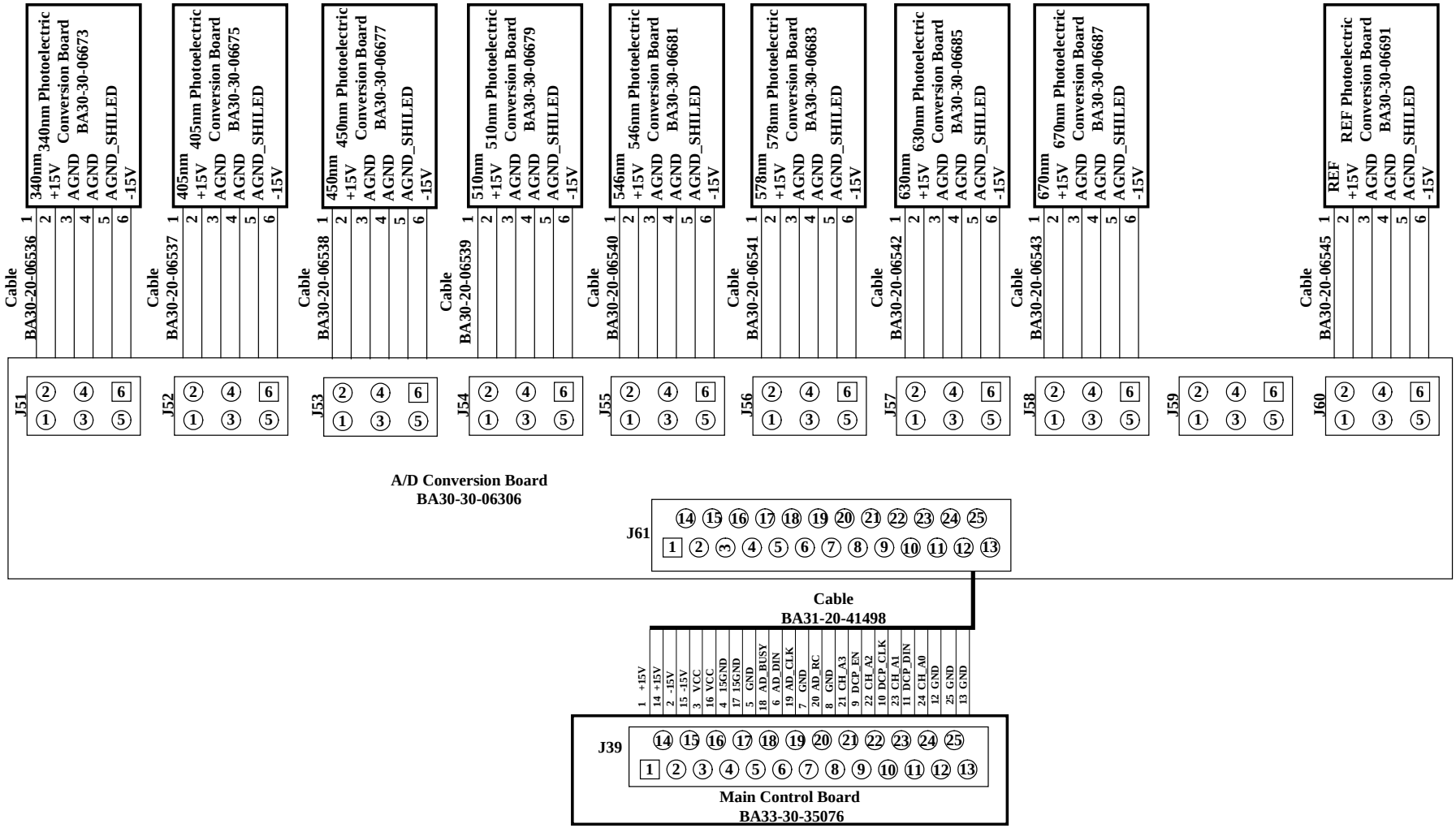


Figure A-5 A/D Conversion Board

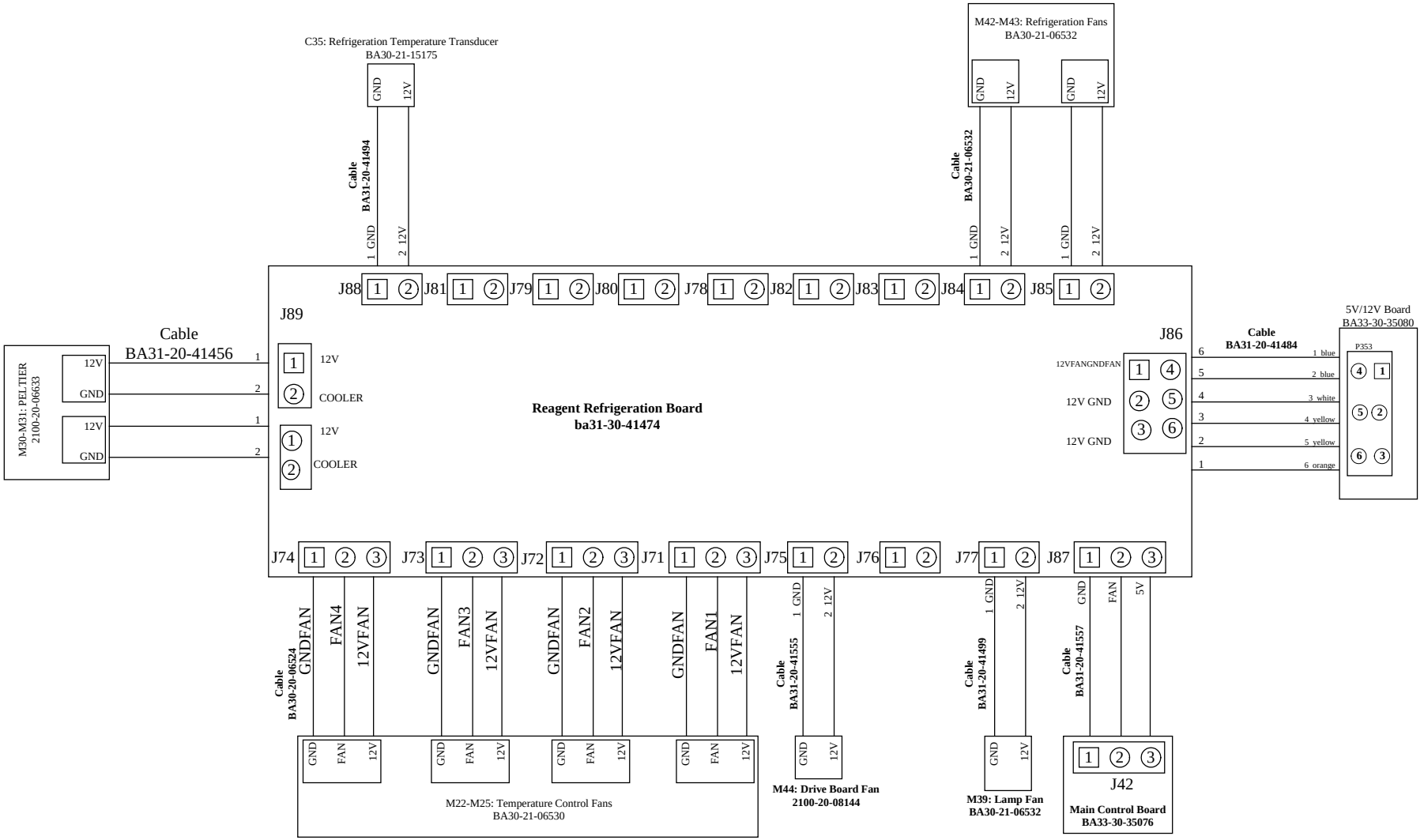


Figure A-6 Reagent Refrigeration Board

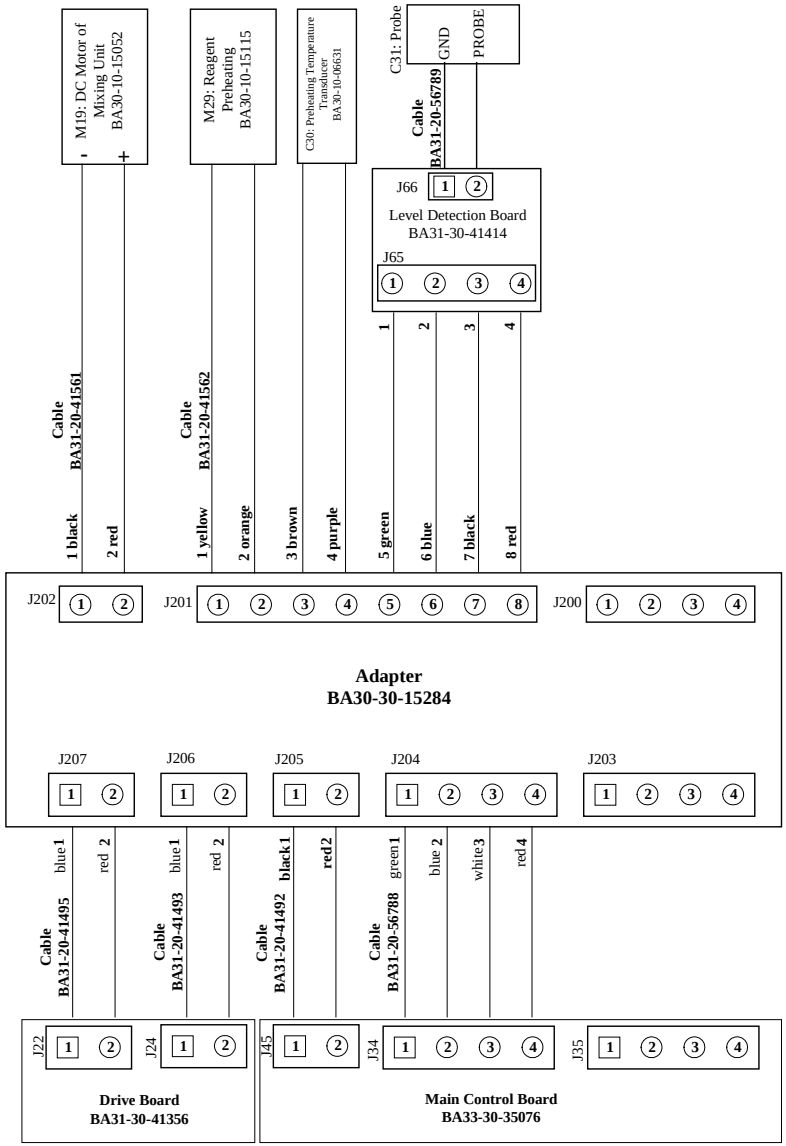
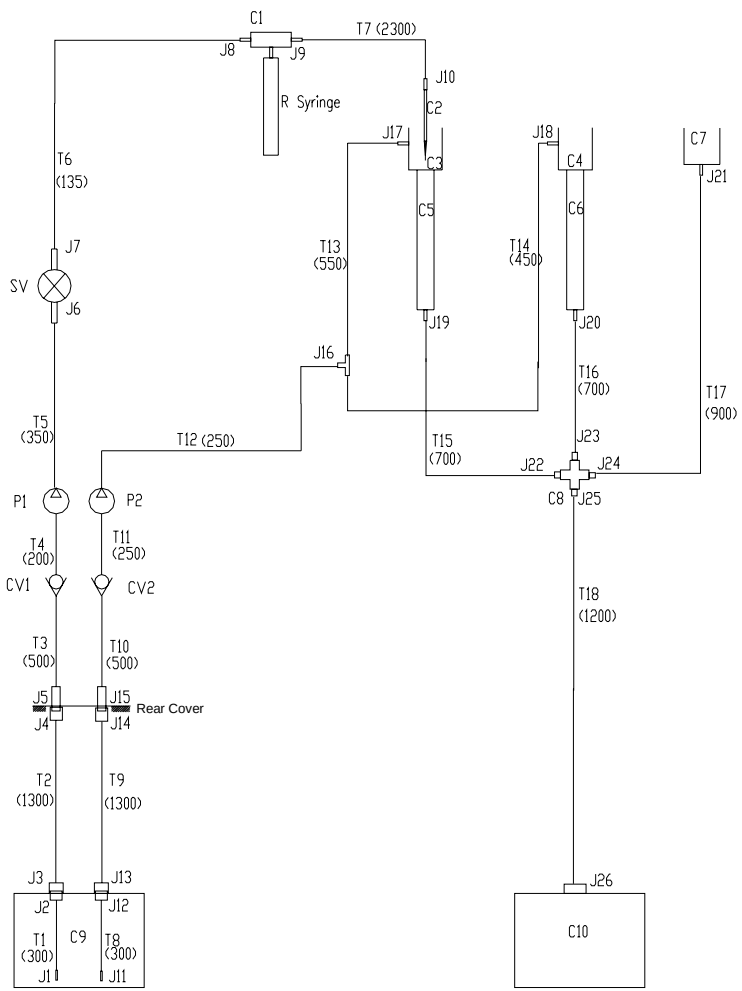


Figure A-7 Adapter



No.	Name	Part Number	Quantity
47	C10	BA31-30-41548	1
46	C9	BA31-30-41547	1
45	C8	BA31-20-41433	1
44	C7	BA30-30-06791	1
43	C6	BA30-20-06643	1
42	C5	BA30-20-06643	1
41	C4	BA30-20-06642	1
40	C3	BA30-20-06642	1
39	C2	BA30-30-14978	1
38	C1	BA30-20-06594	1
37	SV	BA30-21-06470	1
36	P2	BA31-21-41554	1
35	P1	BA30-21-15311	1
34	CV1, CV2	BA30-10-15051	2
33	T18	A21-000010---	1600mm
32	T17	A21-000010---	900mm
31	T15,T16	A21-000010---	2X700mm
30	T13,T14	M90-100071---	2X550mm
29	T12	M90-000025---	250mm
28	T11	M90-000025---	250mm
27	T7	0040-10-32301	2300mm
26	T6	0040-10-32301	135mm
25	T5	M90-000025---	350mm
24	T4	M90-000025---	200mm

No.	Name	Part Number	Quantity
23	T3, T10	M90-000025---	2X500mm
22	T2, T9	M90-000025---	2X1500mm
21	T1, T8	M90-000025---	2X300mm
20	J26	M90-100073---	1
19	J25	0040-10-32309	1
		0040-10-32308	1
18	J21	BA30-20-06647	1
17	J22,J23,J24	M90-100073---	3
16	J19,J20	M90-100073---	2
15	J17,J18	M90-100080---	2
14	J16	3001-10-07066	1
13	J15	M90-100015---	1
		M90-100051---	1
		M90-100009---	1
12	J14	M90-100022---	1
		M90-100025---	1
11	J13	M90-100022---	1
		M90-100025---	1
10	J12	M90-100015---	1
		M90-100051---	1
		M90-100009---	1
9	J10	0040-10-32306	1
		BA30-20-06758	1
8	J9	0040-10-32304	1
		0040-10-32305	1
7	J7,J8	0040-10-32304	2
		0040-10-32305	2
6	J6	0040-10-32302	1
		0040-10-32303	1
5	J5	M90-100014---	1
		M90-100050---	1
		M90-100009---	1
4	J4	M90-100021---	1
		M90-100025---	1
3	J3	M90-100021---	1
		M90-100025---	1
2	J2	M90-100014---	1
		M90-100050---	1
		M90-100009---	1
1	J1,J11	2000-20-03423	2

Figure A-8 Fluid System

Appendix B Test Points of Boards

B.1 Test Points on A/D Conversion Board

Pin	TP	TOP/BOTTOM	Descriptions
R2.2	TP1	TOP	Test the signal at 340nm
R4.2	TP2	TOP	Test the signal at 405nm
R6.2	TP3	TOP	Test the signal at 450nm
R8.2	TP4	TOP	Test the signal at 510nm
R9.2	TP5	TOP	Test the signal at 546nm
R10.2	TP6	TOP	Test the signal at 578nm
R11.2	TP7	TOP	Test the signal at 630nm
R12.2	TP8	TOP	Test the signal at 670nm
R13.2	TP9	TOP	Test the signal at 700nm
R14.2	TP10	TOP	Test the signal of REF
U25.14	TP11	TOP	Measure the current waveform of Q12
D15.A	TP12	TOP	GND
R61.2	TP13	TOP	Measure the oscillation waveform of U8

B.2 Test Points on Drive Board

Pin	TP	TOP/BOTTOM	Descriptions
C74.1	TP1	TOP	Signal ground (SHIELD) from the main control board
U1.5	TP2	TOP	5V and 24V ground (GND)
U1.5	TP3	TOP	5V and 24V ground (GND)
R32.1	TP4	TOP	12V ground (12VGND)

B.3 Test Points on Reagent Refrigeration Board

Pin	TP	TOP/BOTTOM	Descriptions
R13.1	TP1	TOP	Test the voltage of the temperature transducer
R6.2	TP2	TOP	Test the temperature switch signal (high)
R14.1	TP3	TOP	Test the temperature switch signal (low)
C13.1	TP4	TOP	Reference ground
U13.2	TP5	TOP	GNDFAN
Q1.1	TP6	TOP	Test the Q1switch

B.4 Test Points on Main Control Board

Pin	TP	TOP/BOTTOM	Descriptions
U1.27	TP1	TOP	Test the ALE signal of the sample unit
U2.27	TP2	TOP	Test the ALE signal of the reagent unit
D6.1	TP3	TOP	Test the 3.3V supply
R218.1	TP4	TOP	Measure the CLK output of oscillator X1
C27.1	TP5	TOP	Test the +15V supply
C27.2	TP6	TOP	15V ground
C26.2	TP7	TOP	Test the -15V supply
C99.2	TP8	TOP	Test the analog 5V supply
U26.27	TP9	TOP	Test the ALE signal of the temperature unit
R250.1	TP11	TOP	Measure the CLK output of oscillator X2
U25.8	TP12	TOP	Analog ground
R106.2	TP13	TOP	Ground
J48.2	TP14	TOP	Ground
D4.2	TP15	TOP	Analog ground
C116.1	TP16	TOP	Test the 12V supply
C32.2	TP17	TOP	Test the 5V supply
C35.1	TP18	TOP	Test the 1.5V supply
U20.7	TP19	TOP	Measure the TXD signal (OPT_TXD) of the photoelectric unit
U20.5	TP20	TOP	Measure the RXD signal (OPT_RXD) of the photoelectric unit
U2.7	TP21	TOP	Measure the TXD signal (RP_TXD) of the reagent unit
U2.7	TP22	TOP	Measure the RXD signal (RP_TXD) of the reagent unit
U1.7	TP23	TOP	Measure the TXD signal (SP_TXD) of the sample unit
U1.5	TP24	TOP	Measure the RXD signal (SP_RXD) of the sample unit
U15.7	TP27	TOP	Measure the TXD signal (MAIN_TXD) of the main unit
U15.5	TP28	TOP	Measure the RXD signal (MAIN_RXD) of the main unit
U20.8	TP29	TOP	Measure the interrupt signal (DATA_INT) of the photoelectric unit
U20.21	TP30	TOP	Measure the control signal of starting AD conversion (AD_RC1)
U19.19	TP31	TOP	Ground
U34.7	TP32	TOP	Ground

B.5 Test Points on PFC Board

Pin	TP	TOP/BOTTOM	Descriptions
Q5.2	TP1	BOTTOM	Test the switch waveforms of Q3 and Q4
Q5.1	TP2	BOTTOM	Test the drive waveform of Q5
C32.+	TP3	BOTTOM	Test the DC output (390V)
U2.9	TP4	BOTTOM	Measure the reference voltage of U2 (7.5V)
U2.14	TP5	BOTTOM	Measure the oscillation waveform of U2 (100KHz)
C42.+	TP6	BOTTOM	Measure the Vss supply (19V)
C36.+	TP7	BOTTOM	Measure the VDD supply (14V)
D2.2	TP8	BOTTOM	Measure the VPP supply (12V)
Q12.1	TP9	BOTTOM	Measure the drive waveform of Q12 (85KHz)
Q12.2	TP10	BOTTOM	Measure the switch waveform of Q12
Q12.3	TP11	BOTTOM	Measure the current waveform of Q12
U8.8	TP12	BOTTOM	Measure the reference voltage of U8 (5V)
U8.4	TP13	BOTTOM	Measure the oscillation waveform of U8
C63.+	TP14	BOTTOM	Measure the 12V(4.5A) supply

B.6 Test Points on 5V/12V Board

Pin	TP	TOP/BOTTOM	Descriptions
C303+	TP1	BOTTOM	Measure the DC output (390V)
C303－	TP2	BOTTOM	Input side as reference ground
U301.12	TP3	BOTTOM	Measure the VDD supply (14V)
U301.5	TP4	BOTTOM	Measure the oscillation waveform of U301 (100KHz)
U301.14	TP5	BOTTOM	Measure the reference voltage of U301 (5V)
U301.9	TP6	BOTTOM	Test the switch drive waveform
Q301.2	TP7	BOTTOM	Test the switch waveform
C354＋	TP8	BOTTOM	Measure the 12V(10A) output
C355+	TP9	BOTTOM	Measure the output control voltage of the board
C361+	TP10	BOTTOM	Measure the 12V(4.7A) output
C374+	TP11	BOTTOM	Measure the supply of FAN (12V)
C370+	TP12	BOTTOM	Measure the 5V output of the board
C354－	TP13	BOTTOM	Output side as reference ground
D354－	TP14	BOTTOM	Measure the switch waveform of U355 (72KHz)
U352.2	TP15	BOTTOM	Short circuit with the output side reference ground and measure the OVP point of the two 12Vs

Pin	TP	TOP/BOTTOM	Descriptions
U355.1	TP16	BOTTOM	Short circuit with the output side reference ground and measure the OVP point of the two 5V

B.7 Test Points on 24V Board

Pin	TP	TOP/BOTTOM	Descriptions
C416+	TP1	BOTTOM	Measure the DC output (390V)
C416-	TP2	BOTTOM	Input side as reference ground
Q402.2	TP3	BOTTOM	Test the switch waveform
Q402.1	TP4	BOTTOM	Test the switch drive waveform
Q402.3	TP5	BOTTOM	Measure the current waveform of Q402
C404.+	TP6	BOTTOM	Measure the VCC supply (14V)
U405.14	TP7	BOTTOM	Measure the reference voltage of U405 (5V)
U405.9	TP8	BOTTOM	Measure the oscillation waveform of U405 (100KHz)
Q401.1	TP9	BOTTOM	Test the power on/off
C430+	TP10	BOTTOM	Measure the 24V output
C430-	TP11	BOTTOM	Output side as reference ground
D402.1	TP12	BOTTOM	Measure the voltage waveforms at the two ends of the rectifier and fly-wheel diode
U409.1	TP13	BOTTOM	Short circuit with the output side reference ground and measure the OVP point of the 24V

Appendix C Spare Parts List

No.	Part Number	Description
Shell Part		
1	BA33-20-35270	serial communication cable
2	0040-10-32343	air spring
3	BA31-20-41438	top cover
4	BA31-20-41439	left side cover (upper)
5	BA31-20-41440	right side cover (upper)
6	BA31-20-41441	left side cover (lower)
7	BA31-20-41442	right side cover (lower)
8	BA31-20-41443	front cover
9	BA31-20-41444	rear cover (upper)
10	BA31-20-41445	rear cover (lower)
11	BA31-20-41446	desktop cover (reaction section)
12	BA31-20-41447	desktop cover (reagent section)
13	BA31-20-41587	syringe compartment cover
14	BA31-30-41436	protective cover assembly
15	0000-10-10916	acupuncture needle
Mechanism		
16	0000-10-10985	step motor A (small)
17	0000-10-10986	step motor B (big)
18	3001-10-18516	lift motor
19	BA30-21-15116	reagent refrigeration compartment
20	BA31-30-41523	cover of reagent/sample compartment
21	BA31-30-41525	reagent/sample tray assembly
22	BA31-30-41544	reagent tray handle assembly
23	BA30-21-15149	coder sensor with cable for reagent tray
24	BA30-21-15150	home position sensor with cable for reagent tray
25	BA31-20-41391	reaction compartment
26	BA31-30-41530	reaction tray assembly
27	BA30-21-15153	coder sensor with cable for reaction tray
28	BA30-21-15154	home position sensor with cable for reaction tray
29	BA31-30-41526	probe driver assembly
30	BA31-30-41528	mixing bar driver assembly
31	BA30-21-15155	vertical sensor with cable of reagent probe
32	BA30-21-15156	rotary sensor with cable of reagent probe

No.	Part Number	Description
33	BA30-21-15159	vertical sensor with cable of mixing bar
34	BA30-21-15160	rotary sensor with cable of mixing bar
35	BA31-30-56790	sample probe assembly
36	BA30-10-15052	DC motor(6V)
37	BA30-20-06774	retaining nut
38	BA30-20-06775	mixing bar
39	BA30-20-06322	tube bracket
40	BA30-20-06323	tube clip
41	BA31-20-41378	bottle base A (white)
42	BA31-20-41520	bottle base B (blue)
Optical Parts		
43	BA30-10-06365	Halogen lamp (50W)
44	BA30-30-06673	340nm pre-amplification board
45	BA30-30-06675	405nm pre-amplification board
46	BA30-30-06677	450nm pre-amplification board
47	BA30-30-06679	510nm pre-amplification board
48	BA30-30-06681	546nm pre-amplification board
49	BA30-30-06683	578nm pre-amplification board
50	BA30-30-06685	630nm pre-amplification board
51	BA30-30-06687	670nm pre-amplification board
52	BA30-30-06691	REF pre-amplification board
53	BA30-30-15228	340nm pre-amplification assembly
54	BA30-30-15229	405nm pre-amplification assembly
55	BA30-30-15230	450nm pre-amplification assembly
56	BA30-30-15231	510nm pre-amplification assembly
57	BA30-30-15232	546nm pre-amplification assembly
58	BA30-30-15233	578nm pre-amplification assembly
59	BA30-30-15234	630nm pre-amplification assembly
60	BA30-30-15235	670nm pre-amplification assembly
Liquid System Parts		
61	BA31-30-41547	distilled water tank head assembly
62	BA31-30-41548	waste liquid tank head assembly
63	BA30-10-06651	500ul syringe
64	0040-10-32316	500µL plunger tip
65	0040-10-32302	connector p647
66	0040-10-32303	14271 washer
67	3001-10-07066	T connector

No.	Part Number	Description
68	BA31-30-41501	syringe sensor board
69	BA30-10-15051	single-way valve
70	BA30-21-06470	EM valve with cable
71	BA30-21-15311	KNF pump assembly
72	BA31-21-41554	PML5331-NF10 pump assembly
73	BA31-20-41403	3-way connector of syringe
74	BA31-30-41549	4-way connector assembly
75	BA31-30-41550	liquid assembly from EM valve to 3-way connetor of syringe
76	BA30-20-06642	washing pool
77	BA30-20-06647	reagent compartment connector
Hardware		
78	BA33-30-35076	main board
79	BA31-30-41356	power drive board
80	BA30-30-06306	AD converter board
81	BA31-30-41414	liquid level detection board
82	BA31-30-41474	reagent refrigeration board
83	BA30-30-15284	connection board of probes
84	BA33-30-35078	PFC Board
85	BA33-30-35080	5V/12V Board
86	BA33-30-35082	24V Board
87	BA31-21-41491	power socket and switch assembly
88	M07-00061S---	power switch
89	M07-00094S---	Rocker switch
90	TSB1-20-20399	fan of power module
Temperature Control Parts		
91	BA30-10-06633	Peltire cooler
92	BA30-21-06530	fan with cable of reaction compartment
93	BA30-21-06532	fan with cable
94	BA30-21-15175	temperature transducer with cable of reagent refrigeration compartment
95	BA31-21-41465	top heater with cable(220v)
96	BA31-21-41467	bottom heater with cable(220v)
97	BA31-21-41464	top heater with cable(110v)
98	BA31-21-41466	bottom heater with cable(110v)
99	BA31-21-41560	temperature transducer with cable of reaction compartment
100	BA31-30-41551	reagent preheater assembly